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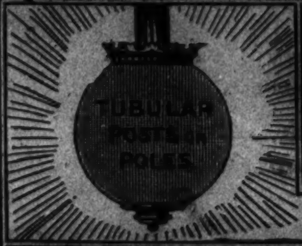

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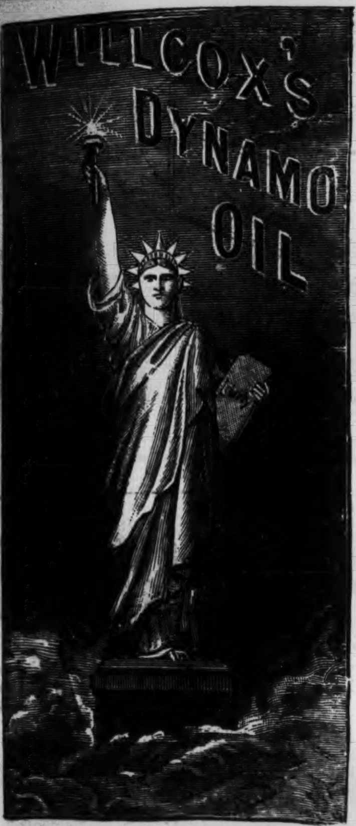

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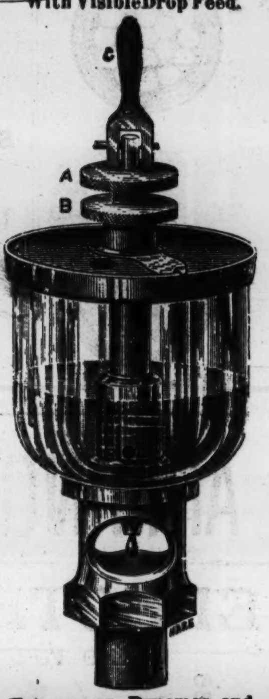

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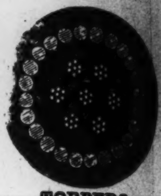

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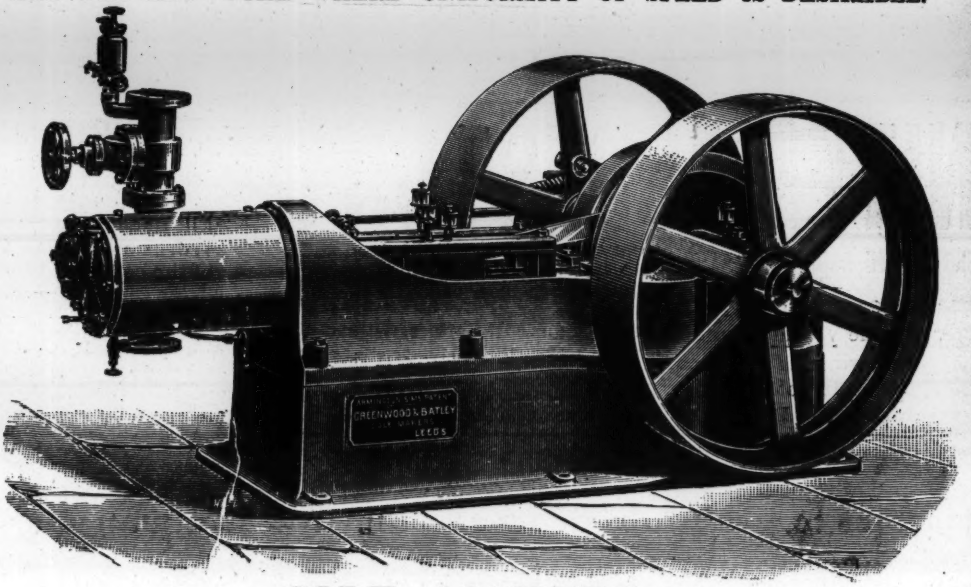

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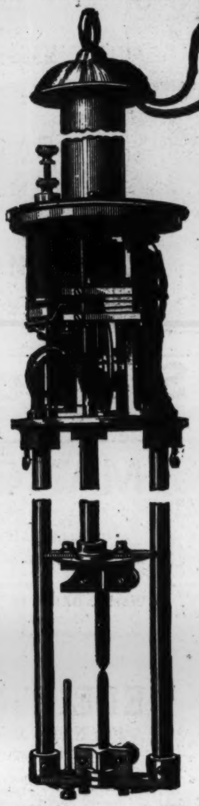

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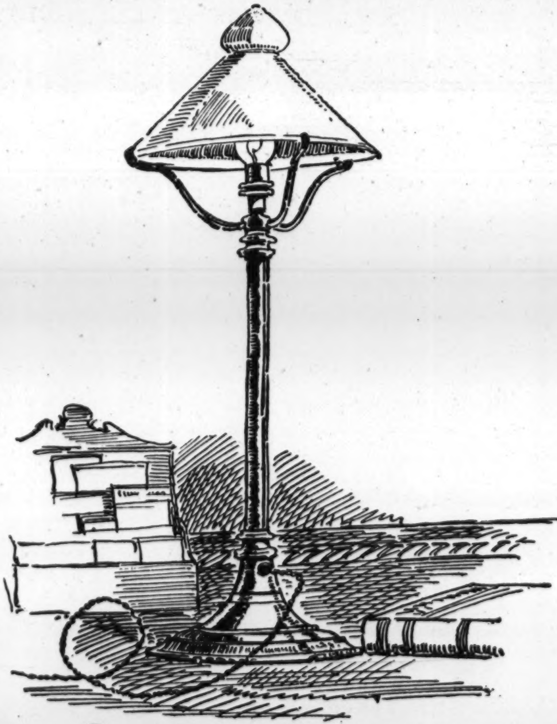

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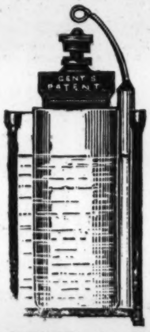

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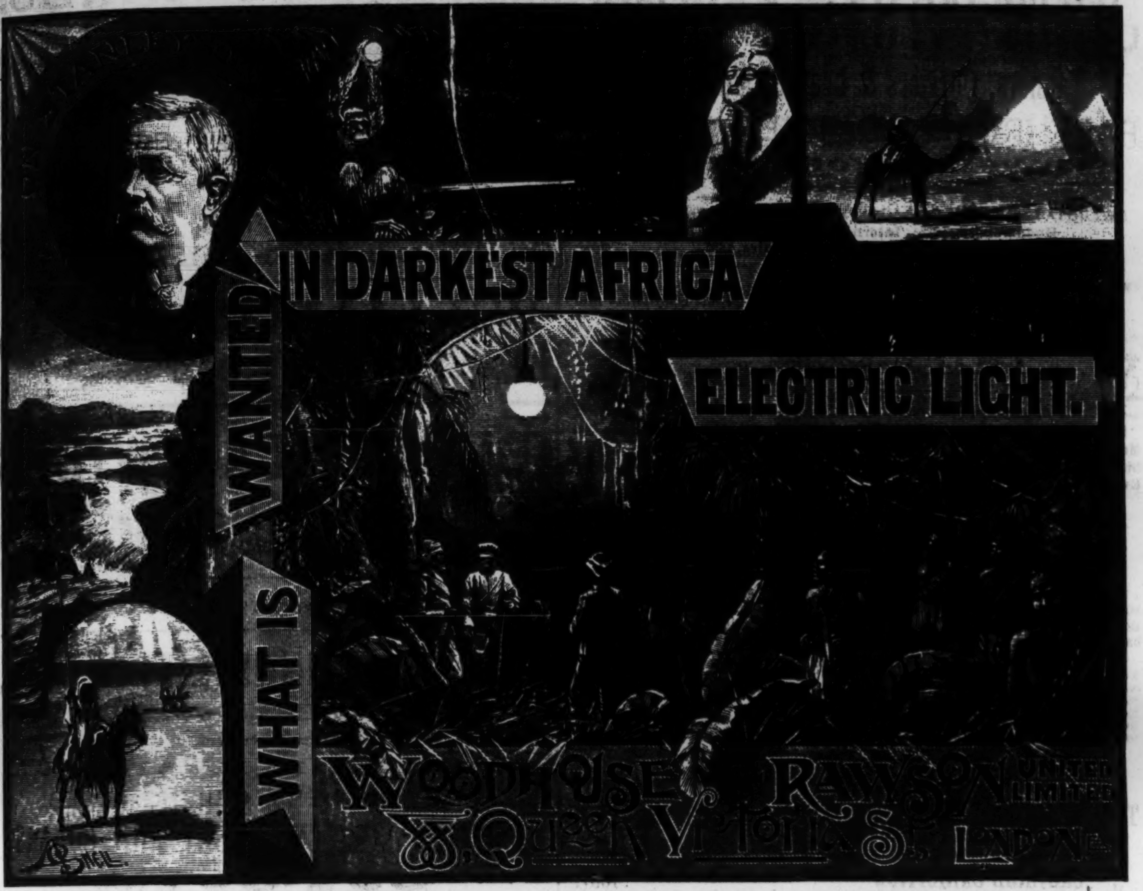
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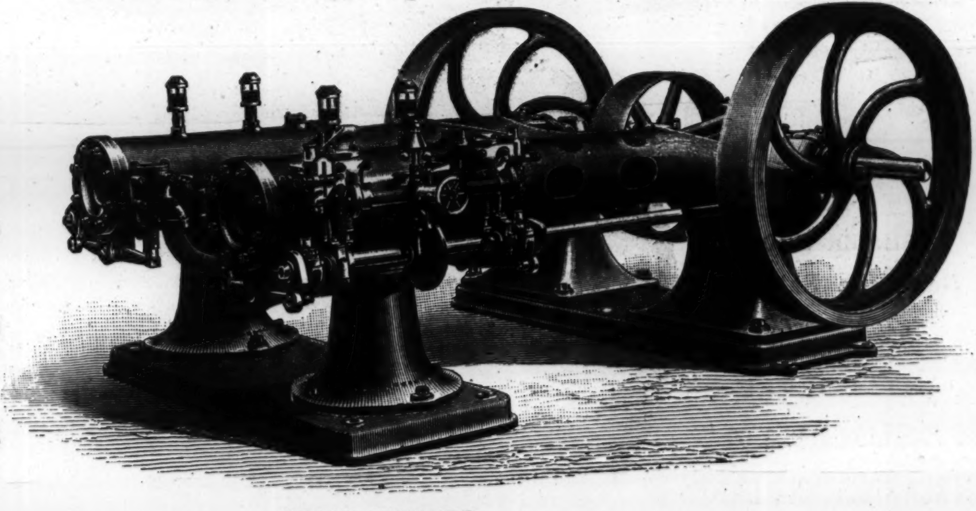

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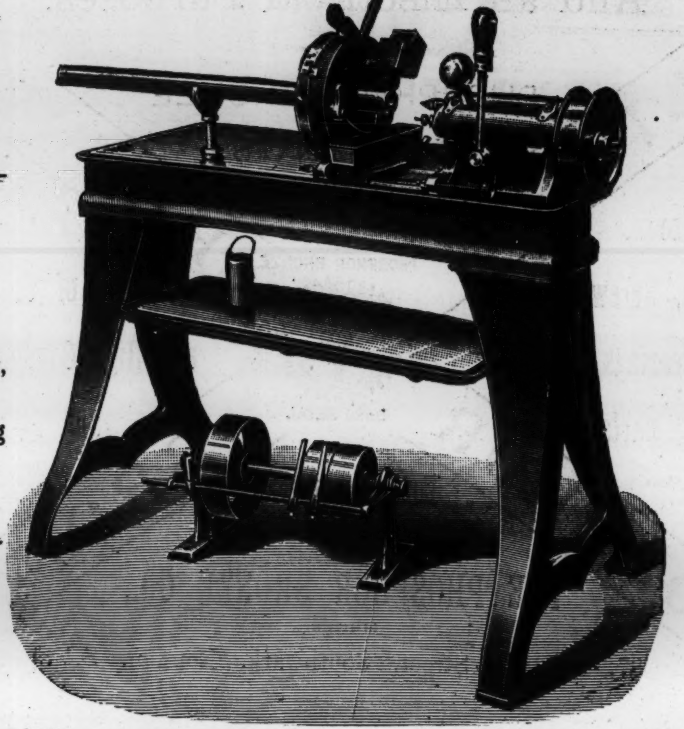

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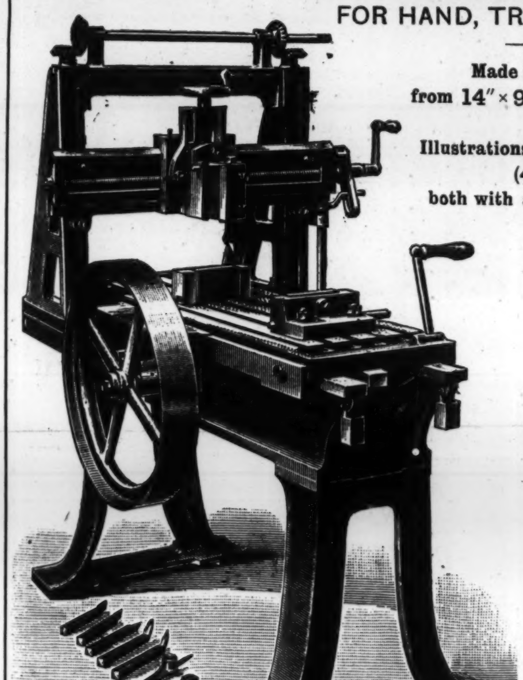

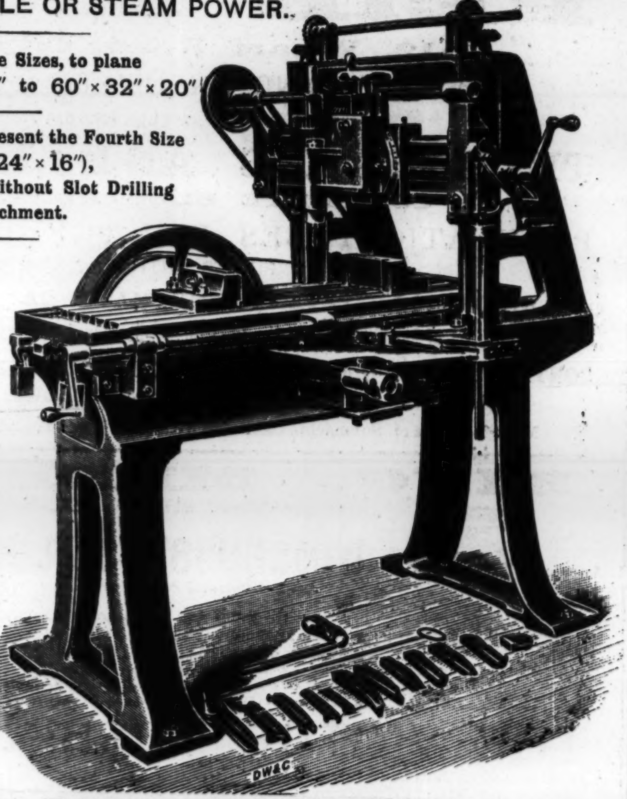

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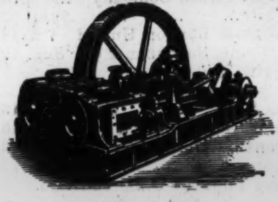

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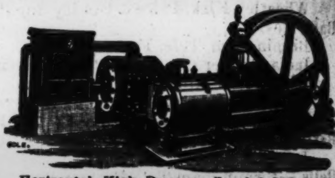

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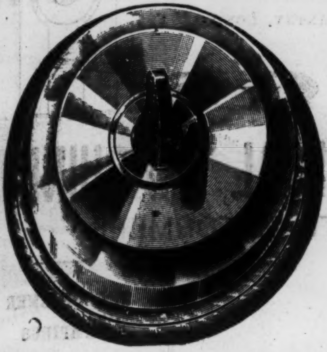

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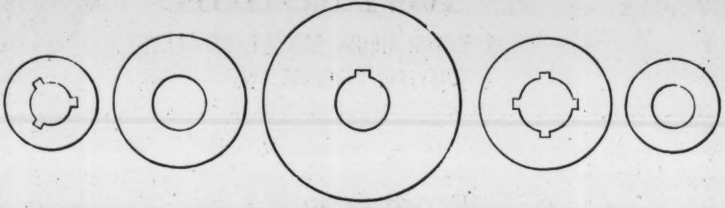

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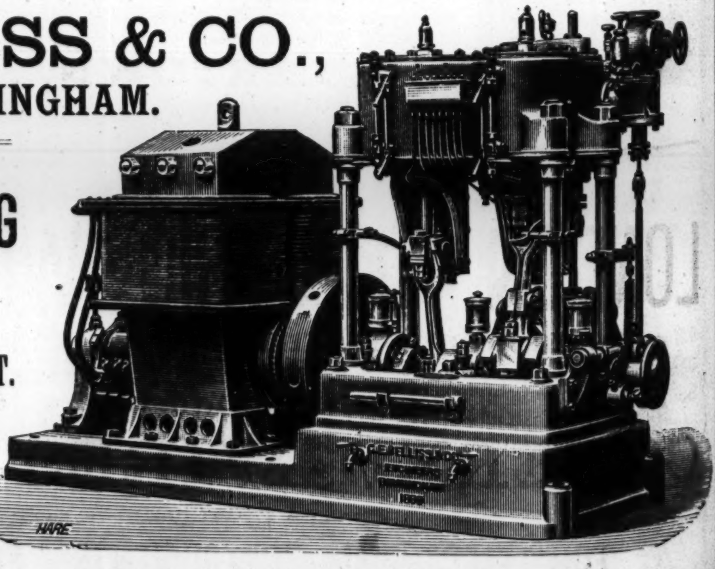

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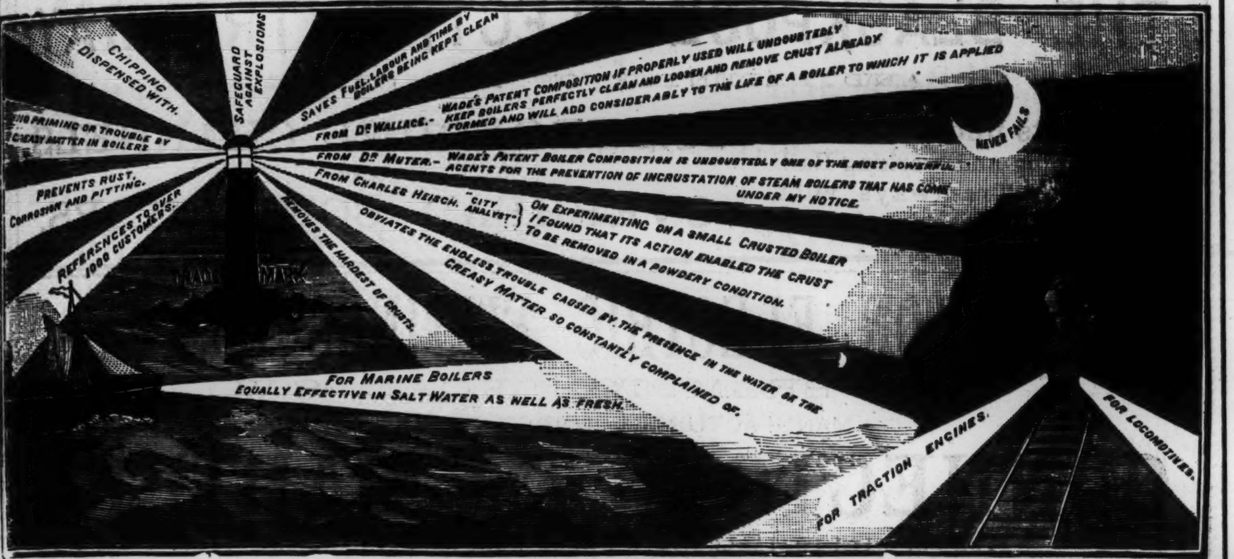
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JAMES BLAKE, *Managing Director.*

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J. L. Wade & Co., Ltd.

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Messrs. J. L. Wade & Co., Ltd.

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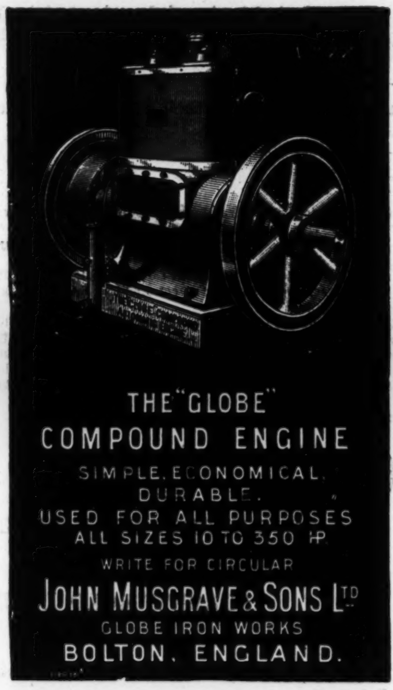

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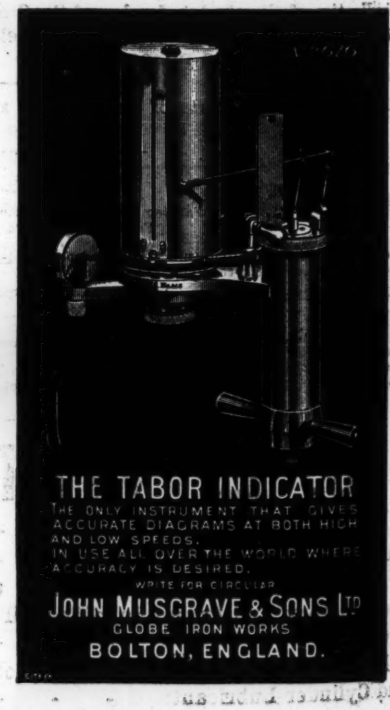

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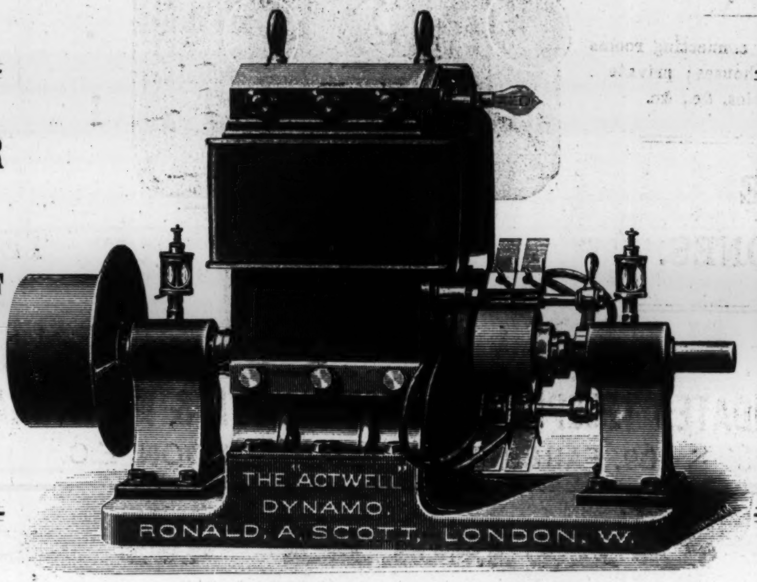

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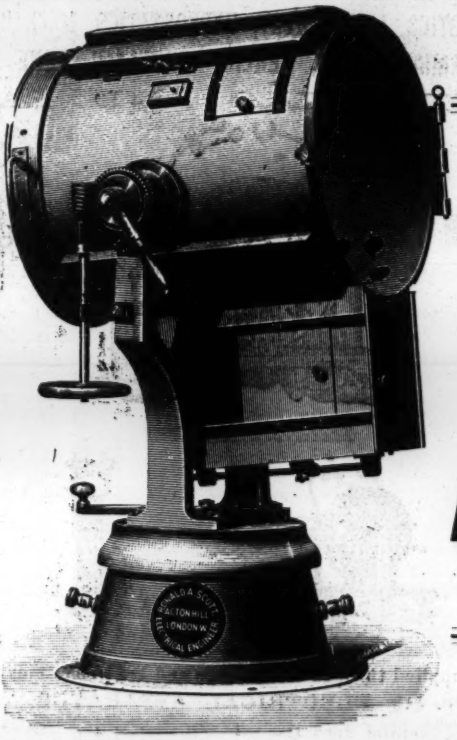

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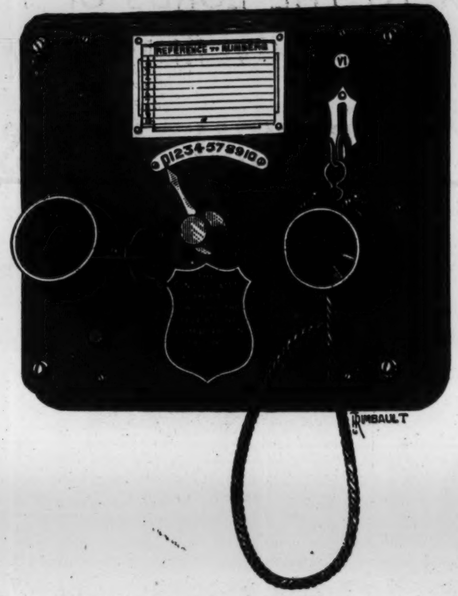

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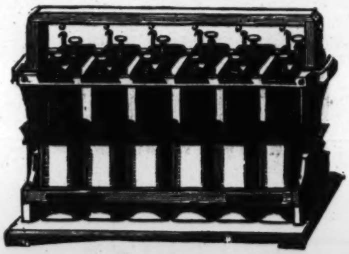

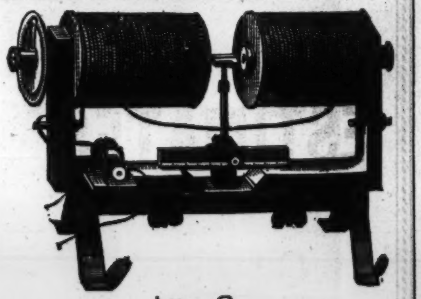

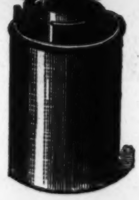

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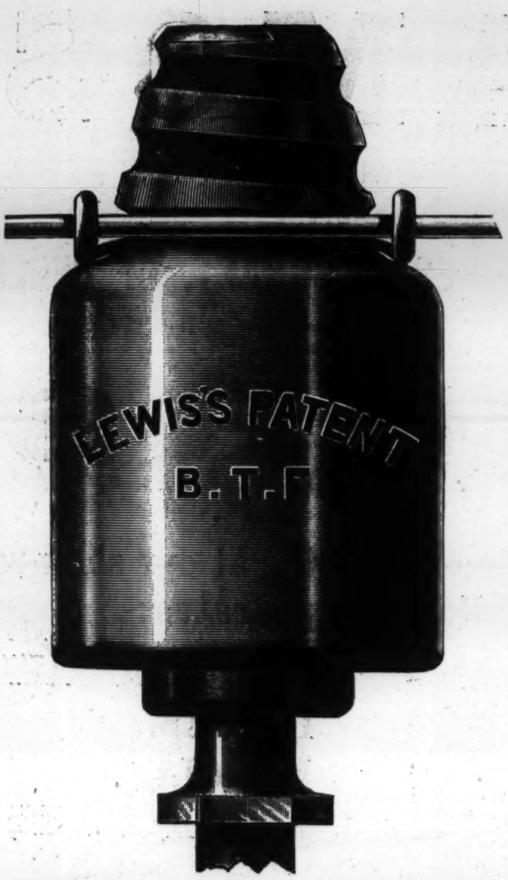

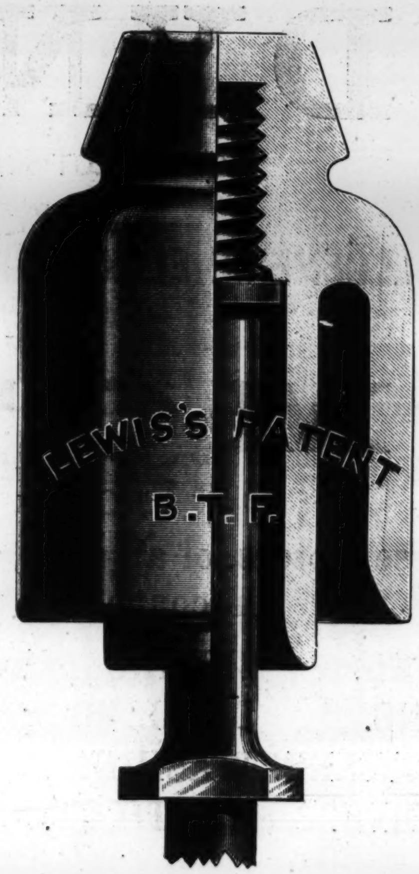

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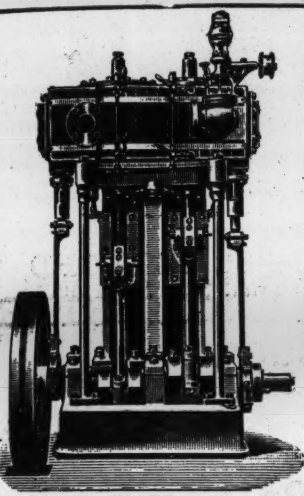
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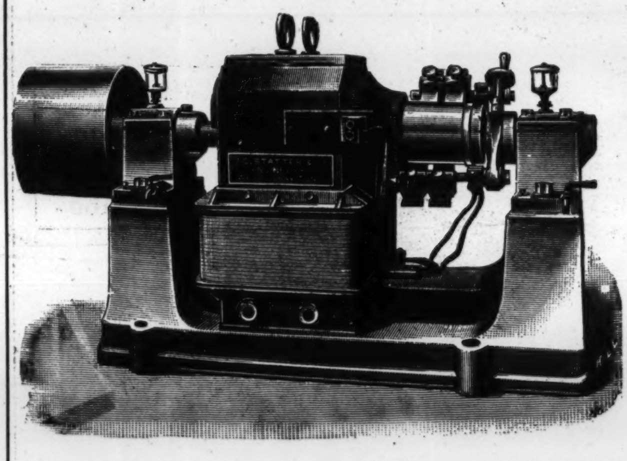

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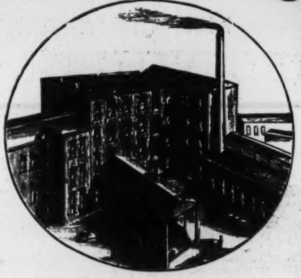
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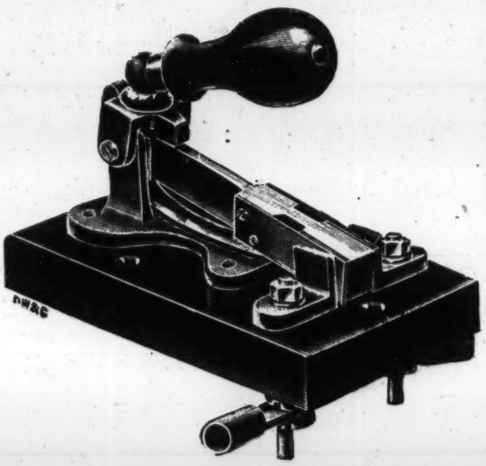

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ELECTRICAL REVIEW.

VOL. XXVIII. FEBRUARY 13, 1891. No. 690

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CONTEMPORARY VIEWS ON ELMORE PROSPECTS.

We have already stated that the opinions we have previously expressed on the Elmore question need no modification after our inspection of the works, but it will be of interest to our readers to learn the views of some of our contemporaries on the subject.

One of the financial papers which had previously very strongly criticised the Elmore methods in its own branch gave a somewhat flattering account of the inspection, and, true to its financial instincts, made prominent mention of the gold and silver recovered from the dross.

Our twelve-week old contemporary, which distributes electricity in penny numbers, states that "both from the theoretical and practical point of view the Elmore process is a decided success, all that is required to make it a great commercial success as well, is that it must be carried out on the large scale the company is now getting ready for. When this is done, everybody must see the immense advantage of the Elmore process;" and on its monetary page it further says:—"For the last few months the Elmore Companies have been subjected to a vast amount of adverse criticism from various quarters. . . . As a consequence, distrust has been created in the minds of shareholders and the public generally. . . . The extensions of the works will be complete in a few weeks, and when this is accomplished, there is no doubt but that the shares will greatly improve in value."

A contemporary, much esteemed by every electrician, contains the statement that "the claims of the Elmore Company to have produced a copper in many ways unique can hardly be disputed. With the monetary aspect of the process we are indisposed to deal; that is a matter for the financial papers and the shareholders in the company. Their directorate seems well satisfied, and is confident of underselling other makers of such articles as they manufacture, and at a very handsome profit to boot. The process is eminently rational, and certainly practicable, and the question of cost cannot be decided off hand. It would be interesting to know on what particular claim the validity of the Elmore patents mainly rests." We may remind our contemporary that the essential features of all the Elmore patents are conveniently summarised in our issue of October 24th. In a leaderette, our contemporary further remarks that "the press visit has at all events shown that some commencement has been made in manufacturing tubes, and that the whole affair is something more than a mere catchpenny excuse for financial speculation and the promotion of companies," and then proceeds to allude to some unsatisfactory features in the manufacturing methods and to comment upon the slight electrical advantages offered.

Another of our contemporaries, devoted mainly to engineering subjects, concludes, perhaps the most complete description of the inspection which has been published, with the following remarks:—"It is difficult to deal with the Elmore system without running into the financial question; in fact, the practical value of the whole thing turns on the cheapness of production. That copper tubes of a quality hitherto unapproached by any trade article have been made at the Leeds works is a fact which requires no further confirmation, and has come within our own experience, the question remains whether these tubes can be made at a price which will enable them to compete on the market with those made by existing methods. The Elmore Company say they can, and that the practical experience they have now had amply bears out their previous calculations. The details we have now quoted are sufficient to enable our readers to form a pretty shrewd estimate on the subject."

In our last issue we expressed the opinion that the public was at some disadvantage, by reason of the manner in which technical subjects were dealt with by the general press. The subject upon which we write is both financial and technical. For the reasons we stated last week, the public can obtain no guidance from the general press, and when it turns to the technical press it is liable to meet with the remark that with the monetary aspect of the process it is indisposed to deal. To our view, the Elmore process is just one of those things in which the technical and financial questions are so indissolubly associated, that unless one or other branch of the press considers them together, the public must inevitably fall between two stools. We refer to the public, because when attention has been directed to an enterprise, as it has been in the present case, it concerns the public—the possible shareholder as well as the existing one.

Both our important contemporaries express the view that the success of the companies depends upon the cost of production, and the possibilities of the market for the manufactures, and, it seems to us, those are just the points upon which the technical press might be expected to give an opinion. We have expressed our own with more than usual energy, and we refer to the subject again in order that the prominent points may be kept in mind. That copper can be deposited electrolytically everyone knows, that the burnishing process is practicable few will question; that it may for some purposes be an improvement may even be granted for the purposes of argument, and yet the success of the Elmore Companies may be as remote as we have always said it would be. There need be no occasion for surprise that copper tubes of good quality have been turned out. Not so very long ago the world was startled to learn that diamonds could be made artificially. "Both from the theoretical and practical point of view it was a decided success." Diamonds were made. At the first glance it seemed that the philosopher's stone need no longer be sought, and disappointment was naturally keen when it became known that diamonds could be obtained from Nature much more cheaply than they could be made by Art. Many things can be made if only sufficient money be put into their production, but for commercial purposes they must show a capacity for enabling money to be got out of them. The amount of money put into the Elmore process we know. How much is to be got out of it depends upon the cost and the demand. "The question of cost," says a contemporary, "cannot be decided off hand." What we have had to complain about is, that the question of cost was decided much too confidently, not merely off hand, but before-hand. So far as the demand is concerned, the only information gathered is that the tubes are used by brewers and calico printers. Other outlets will doubtless be found; but if not, what are the prospects of a company which depends in France or Austria-Hungary upon the use of tubes by brewers or calico printers? Making every allowance for new methods of manufacture, it is but reasonable to suppose that the company would start on the most profitable line first, and it has started on tubes. It has been manufacturing, so it is said, at the rate of five tons per week for a long time, and all our contemporaries agree with us in stating that the material is not yet in the market. There were no signs whatever of any attempt at manufacturing anything else but tubes. M. Secrétan's "articles" were non-existent.

The ability of the company to undersell competitors should, we think, go forth to the public on something more than the seeming confidence of the directors, or not go forth at all. The directors were, presumably, confident that £100,000 would be the annual income of the wire company. The directors were, presumably, confident that there would be a large output of wire in 1891, since the wire company was formed on the strength of contracts with an important group of wire-drawers to take the entire output of 1891. Some time ago we wondered what that output would be, or whether there would be any output at all. The four bare walls of the wire factory and machinery unmade at the time of the press-view are alone sufficient to intimate that our wonderings were justified.

We hold that, considering the matter as a commercial question, it is quite useless to discuss the technical without taking into consideration the monetary aspect of the process and the manner in which it has been floated. In the words already quoted, "the practical value of the whole thing turns on the cheapness of production," and cheapness of production is largely dependent on capital charges. What sort of return is to be expected from the companies who have purchased the patents for two foreign countries for sums which permit a difference of a trifling £100,000 (for "underwriting") between the gross payments and the net receipts?

It is unfortunate that electro-deposition should have lately become more or less identified with Elmore incidents. Properly applied, there is a profitable present and a greater future for electro-deposition; but its progress will be largely retarded if it should turn out that the use made of the Elmore patents was little, if anything, more "than a mere catchpenny excuse for financial speculation and the promotion of Companies."

Elmore Copper. AN important point, and one which tends to refute the assertions made by the promoters of the Elmore companies as to the great commercial value of the process, seems to have been generally overlooked. It will be remembered that M. Secrétan estimated for the French Company that a profit could be made on a production of 225 tons weekly. Thus, on the assumption that it requires a weekly output of 225 tons to earn a profit in France—and it may be taken for granted that a similar production is necessary in England—it would be interesting to know what is the present *actual loss* on the out-turn of five tons weekly in Leeds. This is a point which requires explanation. Let us, however, see what a gentleman who has had considerable experience in the manufacture of copper tubes from a commercial, not an experimental, point of view, has to say on the subject. In writing to a journal representing the mining interests, this manufacturer states:—"I doubt very much if the system can be applied to anything beyond special occasional work—say tubes of large diameter—for it so happens that the bulk of tube work is in small tubes of 2 inches and under. I fear our depositing friends would find some difficulty in executing promptly an order for 2,000 loco. tubes all one bore." After referring to the fact that for continual work seven days of 24 hours each are required to deposit $\frac{1}{8}$ inch thickness of copper on a mandrel, he goes on to say:—"We will presume that the tubes in question are $\frac{1}{8}$ inch thick, and that the 60 tanks be utilised for this order, placing four mandrels in each tank. To complete this order would require 240 turned metal mandrels, and in the space of nine weeks, if all went well, the work would be completed. I leave my readers to estimate the cost of the mandrels and the whole plant at work for nine weeks on an order that a Birmingham tube maker could complete in the course of a fortnight without interruption to general work." This is, however, not all, as the multiplication of mandrels necessary for the general manufacture of tubes would be such as to debar any chance of competing rapidly. This authority thinks as little of M. Secrétan's remarks as he did of his (the latter's) "great and vain attempt to corner copper." Another correspondent brings forward some hard nuts to crack. He states that: "Whatever one's views may be as to the beauty of the Elmore process as a process alone, one's faith in its adaptability to modern commercial requirements is hardly increased by the careful examination, or by following out facts and figures to a logical conclusion." After assuming a weekly production of 225 tons to make the French works pay, the same correspondent concludes that there would be required on a basis of what is being done at Leeds :—"Fifty-six dynamos of 50 volts and 750 ampères, 13 boilers of 250 H.P. each, 3,375 tanks, 646,875 square feet of depositing floor surface, or 56 sheds 200 by 50 feet, and 56 sheds 50 by 30 feet, and 56 times the amount of surface in use for packing, marking, warehousing, &c." Although these figures need not be regarded as even approximately correct, the more extended the calculations made regarding the plant required and the possible rate of production, the less the chances of the Elmore process proving a commercial success become. Considering that the Leeds works have been in existence for over a year, and that the output is now only five tons of copper per week, even when the copper is sought for, the production of 225 tons weekly may, at the present rate of production, be attained during the next generation. To say the least, this is not a cheerful outlook for the shareholders.

The Cardiff Drill Hall Fire.

Mr. Sydney F. Walker is really irrepressible. His latest escapade is in writing to the *Western Mail* regarding the fire at the Cardiff Drill Hall, to which we drew attention in last week's "Notes." He admits that he knows nothing of the affair except what he has gleaned from the published accounts in newspapers, and he then sets to work to deliberately assert his belief that the fire was caused by an "arc" between the loose ends of wires or between one wire and the terminal *from which it had become detached*. The italics are ours, and we ask what right has he to assume that there were any detached wires or loose ends in the place? His letter concludes in a manner which must prove eminently satisfying to the gas interests :—"I do not see that gas could possibly have had anything to do with the matter, beyond possibly driving out any moisture that would otherwise have been present, and thereby rendering the materials surrounding the lamps and wires more readily inflammable." Now, Messrs. Saunders & Co. have absolute proof that the electric light was not the origin of the fire, and, moreover, every holder was found in perfect order after the slight conflagration was extinguished. To still further show the absurdity of Mr. Walker's gratuitous and utterly uncalled for statements, we may add that Edison-Swan 14 B holders, which have no terminals, were used. It is almost incomprehensible that any sane man should publish such damaging comments upon the electric lighting industry as a whole, and this reckless rushing into print, which has characterised Mr. Walker for a considerable period is much to be deprecated, for it seems that an electrician could only write such arrant twaddle upon mere hearsay, unless for the purpose of decrying the wares of a rival manufacturer.

A Dark *Séance*.

The *Star* of the 6th inst. gave a very comical account of a spiritualistic *séance*, and the manner in which the fraud was exposed. It appears that the once fashionable quarter of Lamb's Conduit Street has been for some time the *locale* of two gentlemen named Husk and Williams, who lead their guileless flock three evenings a week into the realms of spirit-land, a collection being made, as after a church service, at the end of each *séance*. These free-will offerings seem to have been sufficient to make the two high priests consider the game worth the candle; but, alas! the perversity of human nature has once more asserted itself, and the mysteries of spiritualism have had a light shed upon them from no less an innocent-looking object than an electric scarf pin. During a dark *séance*, one of these pins worn by Mr. Arthur E. Rossiter, A.I.E.E., suddenly flashed forth its electric rays, and revealed a professional medium masquerading as a spirit with the aid of a luminous-painted slate. A few minutes previously spirit-music tinkled in the air, spirit-forms appeared and floated about the room seemingly quite beyond the influence of gravity, husky spirit-voices spoke direct from the vasty deep—this does not seem possible in Lamb's Conduit Street, but it sounds well—and the disciples sat mystified and terrified. Then came the crowning sensation. The only light by which the spirits were visible was the dim mysterious phosphorescent glow from a slate prepared with luminous paint. By its ghostly glimmer the face of Gladys (Gladys was a spirit, not that lady in the flesh known as Knowles) as seen to appear out of nothingness, was there before them. The blood of some ran cold, when suddenly in this thrilling moment there darted out a clear, bright ray of electric light straight upon the hazy spirit form. Alas for the disillusion! The restless perturbed Gladys was discovered to be Mr. Husk himself, standing up, leaning in a statuesque attitude against the table, enveloped in graceful spirit-draperies, and holding up the luminons slate. There is said to have been an excited scene, and doubtless, in the future, an unknown searcher into the domain of psychical force will be requested to leave his scarf-pin behind before being allowed to participate in a dark *séance*.

Extraction of Precious Metals.

The letter which we publish from Mr. L. Falero is interesting. He shows that the output of the Hamburg Electro-Depositing Works is approximately 2½ tons per day or 900 tons per year. The yield of pure gold from the raw copper employed amounts to no less than 1·18 tons during the year, enough, as he says, to make an appreciable difference in the profit and loss account, but how much of the value of this gold is left for profit after the expenses of extraction are paid we are not informed. Still it opens up a new field for discussion, and we shall be glad to hear the opinions of practical electro-depositors on this particular topic.

Professional Etiquette.

The question of breaches of professional etiquette amongst electrical consulting engineers has already been dealt with in the Review, and probably it may be necessary to go yet further in this matter, if rumour is to be credited. We do not particularly interest ourselves in the squabbles of engineers so long as they are confined to themselves, but when these petty jealousies affect the whole electric lighting industry it becomes quite another thing and demands immediate attention. We know of one large City corporation whose decision regarding the electric lighting of their streets has been rescinded, or at all events put back for reconsideration, owing to the conduct of a gentleman who has more than once been mentioned in our pages as the fomenter of much ill-feeling, and if we can get at the true facts of a matter which, to our minds, is decidedly disgraceful, we shall not hesitate to publish them.

FIRE TELEGRAPHS AND LONDON FIRES.

By R. VON FISCHER TREUENFELD.

EVERYBODY in this vast metropolis of over four millions of inhabitants knows perfectly well that there is no man who devotes more attention to the proverb : "Time is money," than the gallant chief officer of the Metropolitan Fire Brigade, Captain Eyre M. Shaw. There is, however, the difference that his is not a case of making, but of saving property and therefore money, from destruction through fires, by reducing the minutes and seconds between the time when the fire was first discovered and his appearance on the scene of the conflagration.

When the writer of these lines, in a paper read before the Society of Telegraph Engineers in February 1877, drew the attention of the British public for the first time to statistical data referring to continental fire telegraphs, the utility of fire telegraph circuits, including street call points and the specially beneficial influence which such electrical installations must have on the reduction of the number of "serious fires," was fully acknowledged at a time, when fire telegraph alarm circuits were in this country still a thing of the future. From the statistics given it was clear that a fire brigade, however well equipped and organised, could not attain the best results, unless assisted by a telegraph which possessed the means of reducing delay in the arrival of the brigade at the place of conflagration to a minimum, and it was also predicted that London would, with a perfect fire telegraph system, have its serious fires reduced to an average percentage of 4, instead of 10 per cent, as was the case in 1877.

It was a great satisfaction to find that these data were considered to be of practical value, which was shown by the speedy introduction of fire-alarm circuits with street call points in London. Anticipating that the percentage of serious fires would decrease in proportion to the increase in the adoption of fire-alarm stations and street boxes, it is pleasing to find that such has been the case, as Captain Shaw's annual reports fully demonstrate.

The report made to the Fire Brigade Committee of the London County Council by the chief officer of the fire brigade on the fires in London during the year 1890, appeared —as Captain Shaw's reports always do—early in January. The following table, which is principally compiled from that and similar previous reports shows at a glance all the interesting facts concerning the number of fires, increase of population, and the decrease of percentage of serious fires in proportion to the increased number of alarm points and street call boxes. The table also shows how considerably the call points at which fire alarms can be raised, have been increased. This circumstance has produced a more favourable proportion between the number of alarm points and inhabitants, reducing also the percentage of "serious fires" from 10 per cent. in 1878 to 6 per cent. in 1890. Thus a considerable amount of property must have been saved, a result which stands in close connection with, if not entirely dependent on, the fact of the considerable reduction in the distance which persons desirous of giving an alarm have to go, in order to do it.

LONDON FIRES.

Year.	Number of actual fires, excluding chimney fires and false alarms.			Points at which the inhabitants of London can raise fire alarms, including all fire and police stations and public buildings, in telegraphic and telephonic circuit, besides fire stations without telegraphic communication, and all street call-boxes in alarm circuits.				Lives lost.		
	Total.	Serious.	Percentage of serious fires.	Total number of alarm points.	Street call boxes.	Population of London.	Proportion between alarm points and inhabitants.	Total number of lives lost during the year	Lives lost per 100 fires.	Average lives lost per 100 lives.
							Alarm point to inhabitants.			
1876	1632	166	10·1	160	none	2,805,000	1 „ 17,531	35	2·14	1·86
1877	1533	159	10·4	162	„	2,939,400	1 „ 18,144	29	1·89	
1878	1659	170	10·3	163	„	3,073,800	1 „ 18,857	25	1·51	
1879	1718	159	9·3	170	„	3,208,200	1 „ 18,871	32	1·86	
1880	1871	162	8·7	218	40	3,342,600	1 „ 15,333	33	1·76	
1881	1991	167	8·4	233	44	3,477,000	1 „ 14,923	40	2·01	
1882	1926	164	8·5	271	77	3,611,400	1 „ 13,322	36	1·87	
1883	2144	184	8·6	407	151	3,745,800	1 „ 9,203	39	1·82	2·13
1884	2289	194	8·5	470	220	3,880,200	1 „ 8,256	42	1·83	
1885	2270	160	7·1	510	263	4,014,600	1 „ 7,871	47	2·07	
1886	2149	151	7·0	603	347	4,149,000	1 „ 6,880	49	2·28	
1887	2363	175	7·4	610	349	4,193,640	1 „ 6,875	55	2·33	
1888	1988	121	6·1	629	358	4,238,280	1 „ 6,738	48	2·41	
1889	2338	153	6·5	657	365	4,282,920	1 „ 6,519	44	1·89	
1890	2555	153	6·0	716	385	4,327,560	1 „ 6,044	61	2·39	

There is not the slightest doubt that the percentage of serious fires in London can, and will be, further gradually reduced, say, to about 4 per cent., or even less, instead of the present 6 per cent. But to obtain this result, it would be necessary to improve still more the proportion between alarm points and inhabitants, which is at present 1 : 6,000, and ought to be reduced to at least 1 : 3,000, as is the case in many Continental and American cities.

Applying such an improved state of fire telegraphy to the present population of London, a total number of at least 1,500 alarm points, including fire stations and call points, would be required. This is equivalent to a further increase of 784 street call boxes, making a total of at least 1,169 instead of the present insufficient number of 385 erected in the streets of London.

The question arises as to whether the increase of fire engine and fire escape stations, alarm circuits with increased numbers of street call points, have actually been the means of reducing the loss of life ?

In my second supplementary paper on "The Present State of Fire Telegraphy," read in March, 1888, before the Society of Telegraph Engineers and Electricians, it was my unpleasant duty to point out the unexpected fact that, although the Fire Brigade had been augmented, and the further development of the fire telegraph had had a decided influence upon the decrease of "serious fires," and consequently upon a greater protection of property, the loss of life had not been reduced in spite of these advantages.

The Metropolitan Fire Brigade has increased its fire escape stations from 117 in the year 1880 to 179 in 1890, its fire escapes and long scaling ladders from 135 to 224, its fire alarm points, including electrical street call boxes, from 218 to 716, and the street call boxes from 40 to 385, during the same period of ten years, and, nevertheless, the average death roll has increased from 1·86 to 2·13 lives lost for each 100 fires, an unfortunate circumstance, occurring not only in London, but in many other large cities.

On the other hand, 151 lives were saved during the last year, and in many cases heroic bravery was displayed by the members of the Fire Brigade in so doing.

The statistics, nevertheless, show that the protection of life from fire in London is not so visibly influenced by a greater efficiency of the fire equipment and by the extension of fire telegraphs, as in the case of the protection of property, as might reasonably be expected, the former depending very often upon factors which lie much beyond the reach of even the most efficient brigade.

It appears rather, that the Metropolitan Fire Brigade has long since arrived at the utmost limit which human efforts can attain for the protection of life in cases of fire, viz.: at the low average of about two lives per 100 fires, and that that rate is principally kept at its low figure by the renowned bravery and deeply-rooted sense of duty of the corps of the London Fire Brigade.

Let us hope then, that these facts, emanating so visibly from Captain Shaw's annual reports, will be considered by the Fire Brigade Committee of the London County Council as decidedly in favour of the plan already adopted, viz., to continue enlarging the alarm circuits round fire stations. It can therefore be safely anticipated that by increasing the number of street call points by three times their present number, the percentage of serious fires will be reduced to 4 per cent., or even less, thus insuring the property of the wealthiest metropolis in the world in a still higher degree against destruction by fire.

THE MEYLAN-RECHNIEWSKI ELECTRICAL-ENERGY METER.*

By E. MEYLAN.

Every one interested in electric lighting from central stations knows that in the present state of affairs such enterprises are rarely very profitable to those that undertake them, especially in large towns where the conditions attached to the establishment of systems are very irksome. Before the conditions of this industry can become normally economical, its working must be protected by all possible safeguards. The first of these consists in providing against the wasting of the current on the premises of the consumer; thus the contracts should be limited to public lighting, where the consumption can easily be checked. If, therefore, it happens as we have found in some instances, that companies return to this system after having tried meters, it is because these instruments are not as yet sufficiently reliable.

A meter may fail in two ways: by the inaccuracy of its indications, and by its imperfect working. Under this last head we must include stoppages and inability to act at the time of starting; that is to say in cases where the meter does not begin to act directly it is connected with the system of distribution, or directly the latter is started.

The first case is the one to which most attention is given. Inventors always dwell on the marvellous accuracy of their instruments, and when a professor or electrician tests a meter, it is to this point that his attention is chiefly directed.

But the director of a central station looks at the matter from quite another point of view. It signifies little to him that the indications of the meters are correct within ·5 per cent., if, out of 10 instruments, there is one which from time to time does not act or which stops. We need not dwell further on this point, as it is well known to practical men.

Acting upon this opinion that the greatest importance is to be attached to certainty of working, we have, jointly with M. Rechniewski, constructed the meter which we will now describe in detail.

The readers of the *Revue Internationale* and of *L'Electricien* have been kept so well informed of the progress made in electricity meters that we have no need to describe the various instruments that have preceded ours.

Meters may, as is well known, be divided into two great classes, viz., continuous integrators and discontinuous integrators, or instruments giving automatic readings. The first are represented at present by chemical meters, and by what have sometimes been termed motor-meters. They are characterised by the fact that the apparatus shows at each instant the quantity sought, *i.e.*, $\int I\,dt$ or $\int E\,I\,dt$, as the case may be, either by the accumulation of a metallic deposit, or by the fact that the speed of a movable indicator is at each moment proportionate to the electrical power or to the current. The meters of the second class perform the work of a man employed to take at equal intervals the electrical power or the output, the instrument summing up automatically these variable quantities. Our meter is one of this kind.

We will consider the various parts that constitute a meter giving discontinuous readings, and the conditions they have to satisfy. The three most essential are: the galvanometer or measuring apparatus, the motive mechanism and the registering apparatus.

Our attention is first called to the measuring apparatus, and here we must consider what it is that we have to measure. On this point we agree entirely with M. Hospitalier; the central works supply electrical energy, therefore this must be indicated by watts; on the other hand every wattmeter is converted into a coulomb meter when the potential is kept constant, so that this apparatus no longer presents much interest except in a laboratory where batteries and accumulators are being studied or for the testing of the batteries of accumulators for central stations. But in both these cases absolutely automatic action is superfluous and a registering apparatus is more suitable.

Amongst wattmeters may be distinguished those instruments in which the deflection is free, and those in which the current only produces a pressure or a couple in which equilibrium is produced by a stop and which is estimated by means of an equal force or couple of a contrary nature. We prefer this last type of galvanometer for the following reasons:—

1. The inertia of the parts does not come into play, in other words a periodicity is realised spontaneously.
2. The proportionality is much more easily obtained.
3. The efforts, or electro-dynamic, or electro-magnetic couples may be more considerable; as there is no appreciable displacement of the movable part, the maximum of effect is more easily attainable. Whatever measuring apparatus is adopted, the degree of accuracy obtained will, all other things being equal, be greater in proportion as the effort is greater, and from this point of view electro-magnetic action has a great advantage over electro-dynamic action; nevertheless the conditions of proportionality and the consideration of the alternating currents have led us to employ for our wattmeters a pressure electro-dynamometer from which we have thought to obtain the maximum of effort. The arrangement which best realises this condition was indicated some time ago by Maxwell; it has since been applied by Sir W. Thomson in his last series of measuring instruments. It consists in utilising the action of two fixed bobbins upon a flat bobbin placed parallel and as near as possible to the two first.

The readings of an electro-dynamometer of this type may be taken by two different methods: by the action of a movable weight, as in M. Marès' apparatus, or by the torsion or tension of a spring. A movable mass has an invariable weight, but a counterpoise is too sensitive to shocks and vibrations. The spring has the drawback of varying with the weather and the temperature. But, on the other hand, it is much easier to stretch or twist a spring continuously than to displace a weight and draw it back.

If, therefore, as regards accuracy, the advantages of the two methods are about equal, from the point of view of the simplicity of the auxiliary mechanism, the spring is far preferable. In short, the backwards and forwards movement which must be imparted to the movable counterpoise of a Thomson balance can only be realised by elaborate mechanism, with alterning movements of a most complicated nature. We, on the contrary, have succeeded in arranging a system of readings by means of the torsion of a spring, the raising of a lever-arm and the release of cams, the whole constituting a movement which is always in the same direction, so that nothing can be easier than to connect this mechanism with the motive axle.

This brings us to the most important part of the automatic meter, viz., the motor which, as a rule, regulates, by the constancy of its speed, the equal intervals of time between the readings, or rather the equal intervals of time during which the readings are taken. In all the meters with which we are acquainted, this is effected by means of clockwork mechanism, wound up by electricity and provided with a regulator, or by an isochronous motor with interrupted currents. Now these methods have two distinct drawbacks; the first, which is the most apparent, results from the electrical contacts and sparks; notwithstanding all precautions, these contacts in the long run get clogged and refuse to work; moreover, the motive effort being essentially intermittent, we must be absolutely certain that it will act in the position taken by the motive portion every time it comes to rest. The second difficulty consists in the regulation of this motor; none of the simple regulators employed in clockwork mechanism are efficacious except within very narrow limits; this part must therefore act upon the contacts to make the number or the duration of the electrical impulsions vary with the variations in the mechanical resistance of the apparatus. This entails many fresh possibilities of accident.

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* *L'Electricien.*

We hope to obtain better results by employing a stronger motor, viz., one of the Gramme type, which gives off no sparks and has no dead point. For our purpose all that we require to do is to fit it with two attachments; one to ensure the starting, the other to regulate the speed.

A permanent current motor supplying the very variable power necessary for effecting the readings and giving at the same time the factor time, has the additional advantage, which is not without its importance, of a capacity of being introduced directly into the shunt circuit required for the wattmeter, so that a single shunt circuit is sufficient. These are the motives which guided us in the choice of the two principal parts of our meter; we have now to discuss the apparatus for registering and summing up the readings. But here we cannot start with general principles, all that we can say is, that it should be as simple as possible. We will explain this mechanism in the course of the full description of our apparatus, to which we will now proceed.

The Meylan-Rechniewski meter, as shown in fig. 1, consists of six principal parts.

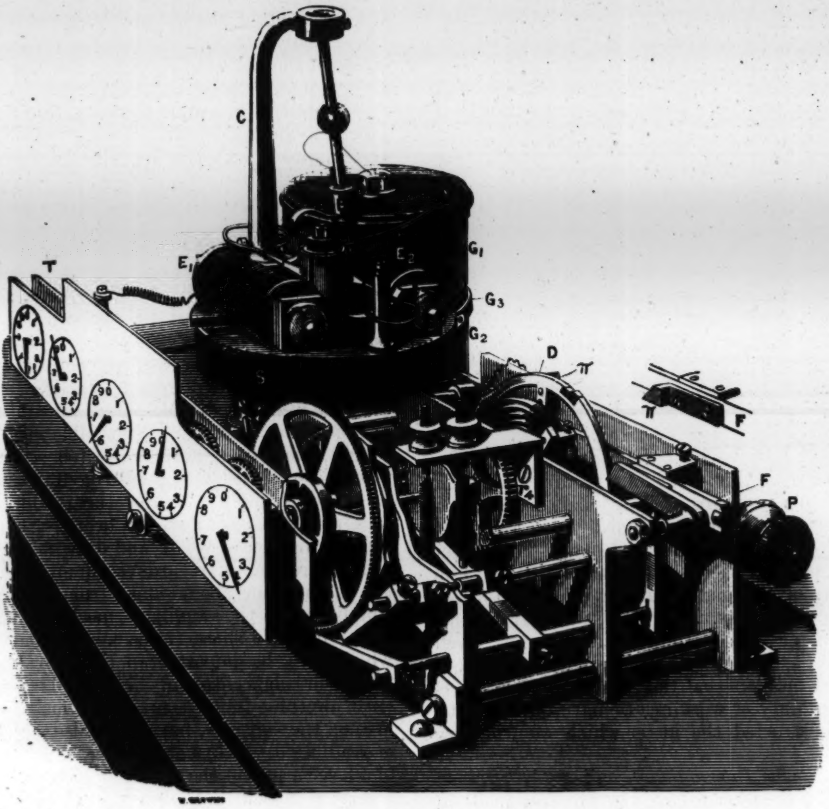


FIG. 1.

1. A permanent current electric motor, M (fig. 2), the speed of which is constant.

2. A system of gearing, reducing the speed of the motor and communicating to a final axle or to the principal axle, A (fig. 3), a movement which is continuous and strictly uniform, the speed of which is ⅓rd of a revolution per minute.

3. An electrodynamic balance, say a wattmeter consisting of one or two fixed bobbins, G_1, G_2, traversed by the principal current, and a movable bobbin, G_3, fixed to a beam, F, mounted on a pivot or on knife-edges; this balance gives rise, under the action of the principal current and the derived current, to a pressure proportional to E I, which pressure is brought into equilibrium by a fixed stop.

4. An elastic cam; this is the part which effects the readings of the balance.

5. A system of friction coupling, controlled by two ratchets, and communicating to the first motive portion of the counter, T, the movement of the principal axle during each reading of the balance. The action of the ratchets depends on the movements of the principal axle of the electric cam.

6. A counter, the various dials of which show in hectowatts the expenditure of energy of the circuit with which the meter is connected.

Constant Speed Motor.—The motor upon which we have finally decided is of a special type; fig. 2 shows an elevation and partial section explaining its working.

It is a disc motor, but one in which the two inductive poles are on the same side as the armature or above this latter; this arrangement produces, as we shall presently see, an actual raising of the induced core under the action of the magnetic field. We thus relieve the pressure on the stone on which the pivot rests.

The inductive system comprises two semi-circular polar pieces attached to two squares connected by two bolts which form the cores of the electro-magnets, E_1, E_2.

The armature is a flat iron ring, insulated and wound round with 3,000 revolutions of fine wire, forming from five to six sections connected with an ordinary collector. This armature is set into an ebonite frame mounted on the axle, V, the endless screw of which sets in motion the system of wheels, r_1, r_4 (figs. 1 and 3).

The inductor is fixed to the column, C, which also supports one of the brushes, $\beta +$; the second brush is held in place by an insulating support. These brushes are formed of an elastic wire terminated by a flat brush of silver wire from $\frac{15}{100}$th to $\frac{20}{100}$th of a millimetre in diameter.

This arrangement is simple, and at the same time, easy to put together and take to pieces; all that is required for this is to unscrew a screw, take away the upper part of the column, and then remove the screw which keeps the hinder polar piece up against one arm of the support.

The axle of the armature fits into a socket, and a guide belonging to the framework of the mechanism (see fig. 3).

The system of regulation, of which we have spoken, consists in shunting periodically the bobbins of the armature. This result is very easily obtained by connecting one of the plates of the collector with the insulated slide which moves the conical pendulum that indicates the speed. One of the brushes, $\beta +$, being connected with the ball of this pendulum, we can see that when the ball, B, touches the contact, C, part of the derived current passes out of the armature, for instance, when this plate is under $\beta -$, the current passes through X, C B, $c\,\beta -$ to the inductor I, without passing through the armature; on the contrary, when this plate is under β +, the whole of the derived current passes into the armature.

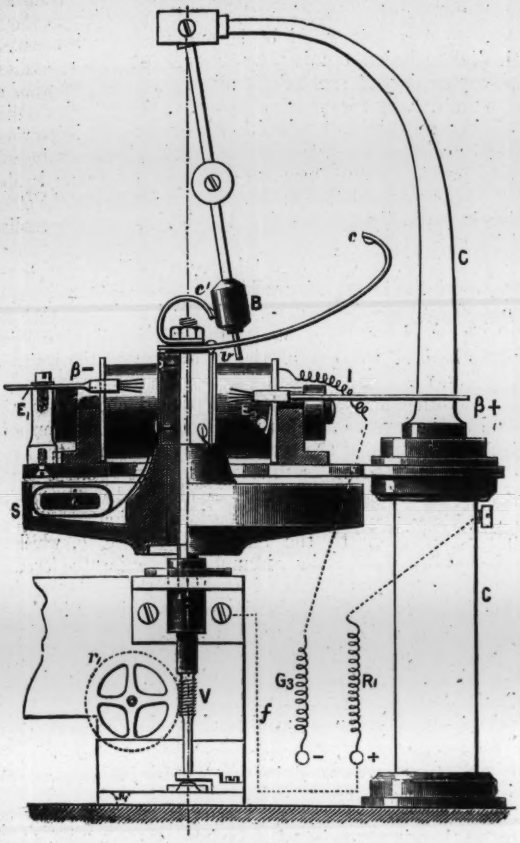


FIG. 2.

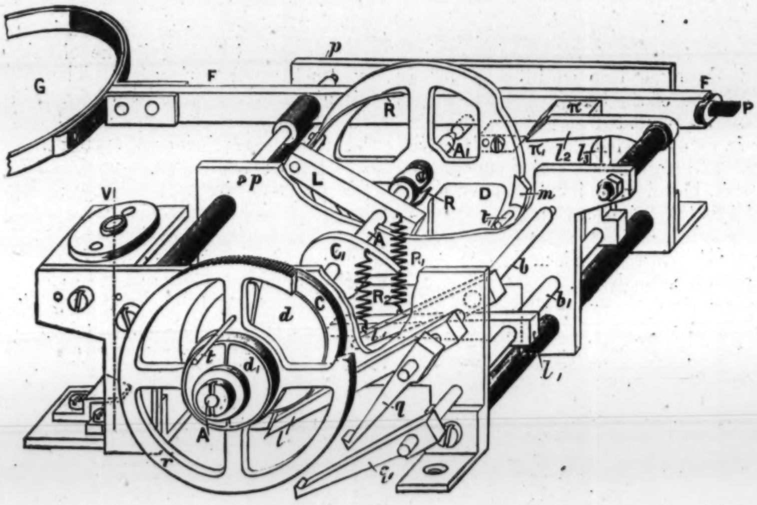


FIG. 3.

On an average we thus produce a diminution of about 50 per cent. of the motive effort, which is, as a rule, sufficient to keep the speed practically constant within considerable limits. In this manner we obtained from one of our meters the following variations in the speed of the principal axle which is connected with the motor by a system of gearing, causing the difference of potential at the terminals of the apparatus to vary :—

Difference of potential.		Duration of one revolution of the principal axle.
87 volts.	...	181·5 seconds.
91 "	...	180·3 "
96 "	...	179·3 "
100 "	...	178·3 "
104 "	...	177·5 "

Thus, with a variation of 17·7 per cent. in volts, the variation in the speed was only 2·2 per cent.; within the practical limits of electric lighting, say with a variation in volts of 10 per cent., the maximum of error would only be about 1·5 per cent.

The sparks at C, B, are absolutely invisible, for they arise merely from the breaking of a short circuit traversed by ·025 of an ampère; moreover the contact is always perfect, the spring, C, causing the revolution of the ball in one revolution of the motor; lastly, the current is never broken, as in the well-known apparatus of M. Marcel Deprez; on the contrary, it may be considered as practically constant, if we are careful to give the armature a resistance which is slight in comparison with the entire circuit.

The object of the regulator is to ensure the rapid disconnection of the motor, which gives rise to a great increase in the derived current, as long as the ball does not leave its central support. This latter consists of a contact, C′, connected with the axle of the motor, and consequently of the mass, and the wire, *f*, with the one extremity of a resistance, X. The other extremity of this resistance being connected with the column, C, we see that as long as there is contact between B and C′, the resistance, X, is shunted, the derived circuit containing only the motor and the rheostat, R_1. The motor then quickly assumes its normal speed, and we need never fear any failure at starting.

It is true that we observe a spark on the breaking of the contact, C, B, but as in practice this only takes place once a day, it does not cause any inconvenience. Of course a reading taken during the disconnection would be falsified, but this contingency may also practically be disregarded. In cases where the meter is required to work with considerable variations in the differences of potential, we employ a double slide, *i.e.*, a slide formed of two parts connected with two diametrically opposite plates.

The ball, B, having reached the limit of its course, then comes between the two contacts in such a manner that two of the plates of the collector are continually at the same potenas one of the brushes. The diminution in the motive effort must be double what it is in the preceding case, and the regulation is much more perfect. In this way we have obtained the following results :—

Volts at the terminals.			Duration of 1 revolution of the motor.
140	...	...	39·1 hundredths of a second
112	...	...	39·9 " "
104·5	...	...	39·8 " "
98	...	...	40 " "
94	...	...	40·5 " "
90	...	...	40·5 " "
86	...	...	41 " "

From 90 to 140 volts, the variation in speed was only 2·5 per cent. for a variation of 50 per cent. in the potential. Clockmakers may not think these results very brilliant, but we fancy electricians will find them sufficient provided that the working of the motor can be guaranteed.

C

Electro-dynamic balance.—This part of the apparatus is shown to the left of fig. 1. The fixed bobbins, G_1, G_2, consist of strips of copper insulated and wound on a central core of wood.

The two bobbins are connected sometimes in parallel, sometimes in series, according to the different types, but in such a manner that their action is combined, and that the force acts in an upward direction.

The current is introduced through two brass blocks, pierced with holes, in which the cables are fixed and held by means of a tightening screw. The movable part is formed of fine wire, G, attached to an ebonite support, which is itself fixed to the beam by a metal ring riveted to the latter. This part is shown in fig. 3. The current is brought to the bobbin on one side through the pivots, and on the other through a very flexible strip of foil, which is fixed to an insulating support near the axis of suspension.

In the little model meter, the beam, F, is simply pivoted at *p*, *p*; but to obtain greater sensibility, we must adopt a system of suspension by knife-edges.

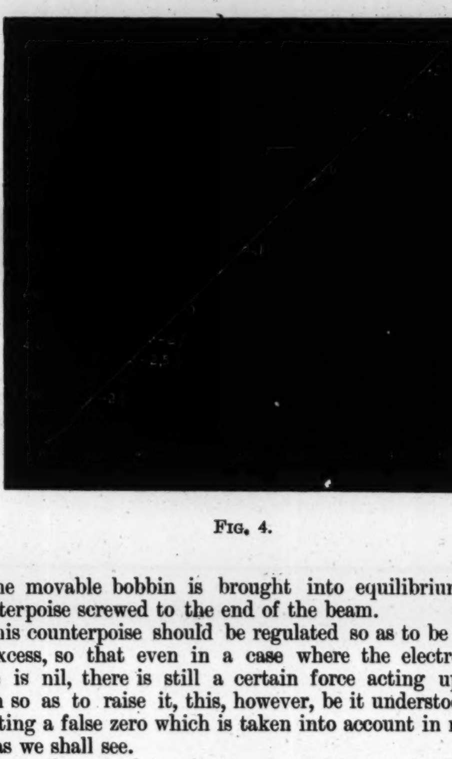


FIG. 4.

The movable bobbin is brought into equilibrium by a counterpoise screwed to the end of the beam.

This counterpoise should be regulated so as to be slightly in excess, so that even in a case where the electromotive force is nil, there is still a certain force acting upon the beam so as to raise it, this, however, be it understood, constituting a false zero which is taken into account in registering as we shall see.

The pull on the beam by the elastic cam is made by means of a piece of steel, π, attached to this beam.

The Elastic Cam.—The elastic cam (fig. 3) comprises the disc, D, which bears the steel cam, π_1, the spiral spring, R, the axle, A, and a rod, L, which connects it with the principal axle, A. The axle, A, is brought to the extremity of A, between points on pivots. As long as the cam, π_1, does not meet the piece, π, of the beam, F, the spring, R, is not twisted, and the axle-tree, A, shares the movement of the axles. At the moment of contact, on the contrary, the cam is stopped and the spring is turned at an angle proportional to the pressure which the beam originally exercised on its stop. At the moment when the cam raises the beam, the reading is finished.

Friction coupling and disengaging mechanism.—The movement being uniform, the total of the torsions gives the total of the periods of the reading. In order to obtain it we must couple the axle, A, with the first wheel of the counter, T, during the periods of torsion. For this purpose we have constructed a friction coupling, regulated by ratchets, one of which is worked by the movement of the principal axle itself and determines the *real commencement of the reading*, whilst the other depends on a catch *actuated by the active force of the elastic cam* at the end of the reading, and disengages the coupling at this moment. Thus this arrangement requires that for the value zero, we should have an active force in reserve, *i.e.*, a certain torsion of the spring, R; the counterpoise, P, must exert a certain excess of pressure on the fixed stop of the lever, F, as we have said.

We effected in the following manner this periodical coupling of varying duration, the details of which are shown in fig. 3. A ratchet wheel of large diameter, *r*, is mounted, with slight friction, obtained by the pressure of grooved discs, at the extremity of the axle, A: it turns the first wheel of the counter, T, by means of a catch, C, which pushes a slide belonging to this first wheel. This wheel, *r*, is provided with two catches, *q*, q_1, the first of which is always in position before the commencement of the reading and is liberated at the moment the reading begins; whereas the other, which is normally free, catches the wheel when the reading finishes.

With this object the first catch, *q*, which is attached to the axle, *b*, and the lever, *l*, is worked by the cam, *c*, which is of such a form, and is held on A in such a manner that the catch is freed at the moment the reading begins, being brought back at the end of the revolution by the action of the spring, R_2.

On the other hand, the ratchet, q_1, is attached to the axle, b_1, and to the lever, l_3, which is held in such a position as to restrain the action of the spring, R_1, by a notch in the lever, l_2. When the reading is finished, the part π_1 of the spring cam is released from the part π of the beam. At this moment under the action of a previous torsion and the torsion corresponding to the reading, the disc, D, which is notched at one point of its circumference, raises the lever, l_2, through *m*; the lever, l_3, is released and the ratchet, q_1, immediately catches under the action of the spring, R_1.

At the end of the revolution a second cam, C_1, which is also held on A, and which presses on the lever, $l.$, fixed on b_1, brings back the ratchet, q_1, and the lever, l_3, stretching the spring, R_1, again.

This last operation naturally takes place only after the first ratchet, *q*, has been brought into place by the cam, *c*, so that the ratchet wheel is not free until the next reading begins.

The regulation of the apparatus is effected simply by ensuring the simultaneity of the release of the ratchet, *q*, and the catching of the ratchet, q_1, when the electro-dynamic pressure is nil; this regulation is performed by the scotching of the cam, *c*, and the adjusting of the weight, P.

Connections.—As we have said, the motor is wound in series and is included in the circuit of the fine wire of the wattmeter and a rheostat. The connections of the shunt circuit are therefore those of fig. 2, in which X represents a rheostat and R_1 the bobbin of the wattmeter. Each meter has four transmissions of current; the two first to the left which are insulated, correspond to the positive cable and to the positive wire of the lamps; they are connected by the large wire of the galvanometer.

The two others, forming a whole, serve to fix the negative cable and the negative wire of the lamps. Lastly the shunt circuit is connected by one end to one of the positive terminals and by the other to one of the negative terminals.

Calibration.—The calibration of all our instruments is arranged that the first dial of the counter indicates a multiple or decimal sub-multiple of the unit of electrical work, the hecto-watt hour. Thus for the meters of the smallest calibre (100-110 volts, 12 ampères), one division of the first dial represents a deca-watt hour.

This calibration is effected, for a type once established, by modifying in the ratio required the total resistance of the shunt circuit which is about 2,000 ω, the speed of all our motors being previously regulated so that the rotation of the principal axle takes three minutes.

Series of Types.—The calibre of a meter is determined by two conditions one of which depends on the galvanometric apparatus and the other on the extent of the measurements to be effected, *i.e.*, on the number of lamps to be registered, if we admit that the meter commences to register at one lamp. In fact, if an apparatus is sufficiently sensitive to show within the required approximation from unity up to *n* times this value, all that we have to do is to adjust the galvanometer so that the minimum electro-dynamic effort corresponds to the energy consumed by each lamp, in order to obtain a meter for *n* lamps. If we wish to obtain types of smaller calibre we have only to modify the winding of the galvanometer. But to come into practical use all these galvanometers must cause only a very slight loss of energy.

On first thoughts it seems that we should fix a certain limit to the loss of volts, ·2 for instance, and give the apparatus a resistance in inverse proportion to the maximum current. Nevertheless, as the electro-dynamic effort is in proportion to the volume of copper and to the loss of energy, and as this increases, like the current, with a constant loss of volts, we may diminish this loss of volts in proportion as the calibre increases, at the same time obtaining more powerful efforts, a condition which is necessary in order to obtain great sensibility.

Thus the relative loss of energy diminishes with the calibre. On the other hand, in all meters in which the readings are not continuous, the sensibility or the range is always much greater in proportion as the dimensions of the registering apparatus and the efforts of the measuring apparatus are more considerable; we are thus led to increase the dimensions with the calibre of the meters.

These are the principles by which we were guided in the establishment of our series of types. Thus our first type of meter, the ratchet wheel of which has 300 teeth, enables us to measure from unity to 70 or 80; when furnished with a galvanometer the resistance of which is $·01^{\omega}$, it constitutes a 12 ampère type, and can measure from one lamp of 8 candle-power (30 watts) up to 40 lamps of 8 candle-power, or 20 lamps of 16 candle-power.

The principal constants of this type are :—

Constant	1 division = 1 deca-watt hour.
Periodicity of readings ...	3′.
Resistance of shunt circuit	$2,350^{\omega}$.
Resistance between terminals	$·01^{\omega}$.
Maximum loss in volts ...	·12 volt.
Loss when there are no lamps to be measured (100 volts)	4·5 watts.
Maximum loss (100 volts 12 ampères)	4·5 + 1·5 = 6 watts.
Maximum electro-dynamic couple	60 centimetre grammes.

It is easy to alter this type so that it will measure as much as 25 ampères by modifying the galvanometer, so that the maximum ampère turns remain constant, with the same weight of couple.

Our second type is capable of registering from one lamp up to 80 8-candle lamps or 40 16-candle lamps.

For higher calibres the dimensions of certain parts must be increased.

Fig. 4 gives the results obtained from a meter of the second type, the ordinates corresponding to the readings taken on the meter, while the abscissæ represent the actual power.

By examining the curve we see that with this meter which is intended to show the expenditure of 40 16-candle lamps, we can register the expenditure of the first lamp, but with a considerable error. After five lamps the indications are correct within about 2 or 3 per cent.

Thus the error in the total consumption will amount to about this percentage on condition that there is on an average a certain number of lamps lighted at once, which will always be the case in practice.

Measurements have been performed by the meter during periods of several hours.

Our meter can be adapted to various combinations which enable it to be transformed into a volt hour meter, and the principle of its construction enables it to be applied to alternating currents. In short, although the presence of the motor causes a considerable delay in disengaging the shunt current in comparison with the principal current, this does not cause the electric balance to give less accurate results as long as the frequency of the reversals is not changed; we have simply to modify the rheostat in each given case.

The only difficulty that presents itself is that on account of this delay we require a very high potential in order to work our motors, although they do not appreciably absorb any more energy than with a continuous current.

We shall probably have occasion to return to this point when this difficulty has been surmounted.

THE GALVANIC BATTERY IN INDUSTRY.

UNDER this somewhat sensational title, M. de Meritens, on the 3rd inst., made a communication to the *Société Internationale des Electriciens*, which was listened to by an audience not as a rule greatly interested in the proceedings of the Society. M. de Meritens's address produced the effect which might have been anticipated on the listeners who filled the hall, and on Thursday morning the most important political journals vied with each other in singing his praises, speaking of his paper as containing an important discovery, and implying that it solved the problem of supplying electricity at a cheap rate.

The figures given by M. de Meritens are too incomplete and have been presented in too vague a form for it to be possible to draw any conclusions whatever from them; we must therefore wait until we have a technical report drawn up by some authority, who, while being no less reliable, would at least be less interested than M. de Meritens, before we can give any opinion whatever as to the value of his idea, of which we can at present only sketch the bare outlines. In the first place, M. de Meritens claims to have succeeded in rendering the galvanic pile absolutely constant as a source of electricity, by employing, on the one hand, pure zinc, and on the other, as the positive electrode, a plate of carbon perforated and covered on the side, facing the zinc, with a sheet of platinised lead, the exciting liquid being water mixed with sulphuric acid.

He placed before the Society a battery of small dimensions which, being short circuited, gave, during about an hour and a half, a constant current of 33 ampères. It is impossible for us to know what would be the output of this battery under normal conditions, or at its maximum power, over a given external circuit, or what would be the consumption of zinc and acid per effective horse-power hour or kilowatt hour in the external circuit, when the cell is under conditions of practical work.

However, this may be, we should obtain, according to M. de Meritens, electrical energy and hydrogen which could be collected and utilised by the expenditure of pure zinc and sulphuric acid for the formation of sulphate of zinc; the composite electrode of platinised lead and carbon remaining unattacked. The sulphate of zinc would then be treated electrolytically, plates of iron being employed as the anode, so as to reduce to a minimum the counter-electromotive force of decomposition of the electrolyte. The products of the operation, for which motive power is of course employed, would be on the one hand pure zinc, which would serve again for other elements, and on the other hand, sulphate of iron, the marketable value of which of course varies with the demand. We will complete this very vague description when we have before us the official text of M. de Meritens's communication, the industrial importance of which it is at present impossible for us to estimate. On the face of it, however, it would appear that the French electrician has been taking a leaf out of the book of his fellow-countryman Perreur-Lloyd.

TELEGRAPHS IN INDIA.

A SUPPLEMENT to the *Gazette* of India, reviewing the Administration report of the Indo-European Telegraph Department gives the history of the work and an account of the company's finances for the year just ended. The capital account of the department, it appears, is something over two lakhs in excess of what it was at the commencement of the year. Quite two-thirds of the amount are accounted for by the adjustment of loss on exchange on English stores for this and previous years. The message revenue is over ten and a half lakhs, a diminution of little less than 70,000 rupees as compared with the previous year, in which for thirty-two days the whole of the traffic along the East Company's lines was diverted to the Indo-European wires, owing to an interruption in the Red Sea. No such diversion took place this year; on the contrary, it was necessary for the company to repair 227 knots, as against 201 in the previous year. Ten faults have occurred during the twelve months, of which one is stated to have repaired itself, five were cut out, leaving four still in existence at the close of the year. It is interesting to read that of the total number of messages despatched to England, 2,403 were State, 10,175 commercial and private, 3,104 Press ; while of this class not less than 120, containing on an average 663 words each, were addressed to the London *Times*. The total is less than that of the previous year, and the percentage of errors, as might be expected, is slighter. The accuracy of transmission between Karachi and Teheran was great, there being only 60 complaints of error, delay, or non-delivering, as compared with 84 the preceding year. There was no delay so serious as to interfere with the receipts, no period under 24 hours being taken into account. The most prolonged interruption was the outcome of a flood in the Kinarigaird hills; the others by wilful damage. It would scarcely be believed by electricians in Europe that the substitution of porcelain insulators for those of iron has produced such unsatisfactory results that their abandonment is under serious consideration. Yet the fact remains that the more extensively the former are adopted the more frequent are the interruptions. Damage is of almost daily occurrence. This is on the Persian section, where the natives use them as targets "for testing the efficiency of their guns or their skill in throwing stones." To such an extent has this description of wilful damage been done, that not less than 10,500 kraus have been paid by the Persian Government and district authorities as compensation. Birds and camels continue to be sources of annoyance and causes of interference with communication. There may be no means of preventing this, but there seems to be some of minimising wilful damage. In November, 1889, on the Teheran coast, the wires were cut, and the extent of mischief reported was lamentable. The year shows that in average speed of transmission the Teheran route still leads, with a record of one hour and five minutes as against Suez, two hours and 21 minutes, while the Turkey route is a bad third with three hours and six minutes. The most important paragraph of the report is that which refers to duplex working on the gutta-percha cable. It is believed to be the first instance of the duplex method being applied with ordinary Morse instruments to a long sea cable. This experiment was made by Mr. Porsman, the electrician of the Persian Gulf section. Some experiments in automatic signalling, considered likely to have useful results, were also carried out by Mr. Preece, one of the superintendents of the same section, and two sets of Wheatstone's instruments have been indented for, with a view of giving practical effect to the system. The Government of India notices with satisfaction both of these experiments, which it considers do credit to the Department.

THE ELECTRICAL CONDUCTIVITY OF SALTS IN THE BUNSEN-BURNER GAS FLAME.

SOME experiments have recently been conducted by S. Arrhenius upon the electrical conductivity of salts in the flame of a Bunsen gas burner.

A burner of the ordinary type was used in these experiments, and the flame was fed with a mixture of atmospheric air, and gas, both being maintained at a constant pressure.

Before the current of air was allowed to mingle with the gas it was caused to pass through a fine spray of an aqueous solution of the salt whose properties it was desired to examine. The degree of concentration of this solution determined the amount of the salt which was carried by the air into the flame. Electrodes were formed by placing two small plates of platinum in the flame, at a distance from each other of 0·560 mm. A battery of forty Latimer Clark cells and a galvanometer of the Wiedemann type were employed in the circuit.

The conductivity of the flame was measured by observing the deflection of the galvanometer, since it was found that the resistance of the flame as compared with that of the remainder of the circuit was very great.

Arrhenius found that the following relation between the intensity of the current and the electromotive force, held good, namely, $i = k f(\epsilon)$, in which equation $\epsilon =$ the electromotive force, $i =$ the intensity, $k =$ a constant, $f =$ a function which remains the same for all salts at all degrees of concentration. Ohm's law was not found to hold good in all cases for conduction in the Bunsen flame, the exceptions being at values below 0·2 Dan.

The conductivity of the salts in the flame was found to be proportional to the square root of the concentration of the solution ; by the conductivity of the salt in the flame is understood the total conductivity, minus that of the flame itself. This law was shown to be practically true for no less than sixteen different salts. When the solutions were extremely dilute the conductivity was observed to increase much more rapidly.

All the salts of potassium conduct equally well, and this statement is also true, for the salts of sodium and lithium; salts of hydrogen, ammonium, magnesium, zinc, cadmium, copper, iron, nickel, cobalt, aluminium, chromium, magnesium and tin do not appear to possess any conductivity. The salts of barium, calcium, and strontium conduct by the convection of small solid particles, and there is some reason for believing that they conduct electrolytically. The conductivity of the chlorides of the alkali metals increases with their molecular might.

Arrhenius also observed that the difference of potential between two metals in a Bunsen gas-flame which contains saline vapours is of the same sign and order of magnitude as when the same metals are placed for examination in some electrolyte. He concludes, that on the whole, when salts in the state of vapour above described, are caused to pass into a Bunsen flame, they behave like a feebly dissociated electrolyte, the chief point of difference being that Ohm's law does not hold good when the electromotive force has a large value.

The original paper may be read in the *Sitzungsberichte der K. Akademie zu Wien*, No. 99.

ELECTRIC LIGHTING IN MADRID.

LAST week we briefly alluded to two events : the issue, or attempted issue, of £75,000 of 6 per cent. first mortgage debentures by the Electricity Supply Company of Spain, and the withdrawal of the contract from, and consequent stoppage of the Matritense Company, which has been for some time purveying electric light in Madrid. There is no connection between these two companies in any way that we are aware of, except that they have been operating in the same city, but that they have been such near neighbours leads us naturally to bracket them, for having the same *locale* the surrounding circumstances must necessarily be to some extent similar. And though we sincerely hope that history may not repeat itself in failure, the narrative of the birth, life, and demise of its unfortunate brother may not be without interest, but be a useful warning to those embarked in or contemplating joining Mr. Hammond's Spanish Company. As when we see a friend who has recently met with a family bereavement, and are in darkness as to whether expectations have been realised, and affliction thereby mitigated, so now we hardly know how much sympathy to offer the last-mentioned undertaking, or whether it should be of a condoling or congratulatory nature, for it is possible that where others sowed it may be reaping, the ill-wind which wrecked the Matritense may have blown it good, and as the latter is dead, we sincerely trust that the English Company may have a share of its inheritance.

The Matritense was originally established by a firm of electrical engineers in Barcelona, to whom were allotted for promotion money and for the plant and material which they supplied by far the greater proportion of the shares. The plant was old type and uneconomical in working, and the over capitalisation, the weight of dead shares the company had to carry, crushed it in its cradle—for the knowledge that profit, if obtained, must go nearly all into the pockets of others, is not conducive to the attraction of extra funds, and, as usual, sufficient were not provided in the first instance. Obtaining the first concession to canalise the streets of Madrid, they laid 500 metres of mains in the principal thoroughfare, the Calle d'Alcala, running from the Puerta del Sol to the Prado and the Parc de Buen Retiro. This effort appears to have exhausted their canalising capacity, for abandoning their buried cables they confined their attention to distributing from overhead wires, the seven miles of which necessitated constant supervision.

At the new Opera House they put up a separate installation with Swiss machinery and let it on rental to the lessee, but would-be concessionaires bethought them to "get at" one of the *employés*, and carried out their purpose so successfully that something was always going wrong, a screw missing here and a screw missing there, until its irregularities were such as to furnish an excuse to a Minister to legally restrain the Matritense from operating it any longer. Then the plant, which was kept going, worked all right. The company received no compensation for their expenditure of 250,000 pesetas—£10,000—or for the loss of the goodwill of supplying the surrounding district, which was fed from this installation at the price of 8 centimes per lamp hour for incandescents and 5 for arcs.

Well, the Matritense is no more. It had a hard struggle, and succumbed; but there are other Richmonds in the field who are very much alive. A theatre close to the Calle d'Alcala has machinery of the newest type, and although not a large one, is capable of being increased to supply the neighbourhood, the best in Madrid, including, as it does, the War Office, four theatres besides itself, and the Calle d'Alcala. Adjoining this theatre is a vacant piece of ground on which a station could be erected large enough to furnish light for nearly the whole of the city. There is no monopoly (except, if we may be pardoned the expression, a partial one in the hands of the gas company): success depending upon influence, bribery, and commercial advantages.

Perhaps 90 per cent. of certain classes of goods used in Spain are manufactured in Germany. Bedsteads, washstands, gas fittings, cutlery, glass-ware of all kinds down to lamp glasses, and tools—the pickaxes in the streets are of German make. There is an important bank, the depositors in which are largely men doing business with Germany. The manager of this bank is also the manager of an electric lighting enterprise, an offshoot of the German Edison Company. This undertaking has an understanding with the Madrid Gas Company, and the latter has the first right to supply electric light at the same price as any other concern will do it at. Any other supplying any district appropriated by the gas company would be compelled to run its cables alongside the gas mains, in many cases crossing them. There not being sufficient room above the gas mains, the cables would have to go underneath, increasing the expense of laying. There would also have to be reckoned with the natural hostility of a competitor whose *locus standi* was a tower of strength, with the possibility of every conceivable obstacle being placed in the way, and the invocation of the law whenever practicable. We know what an annoyance an injunction is in England, and our own electrical suits have shown that litigation can be protracted and costly, even where constitutional indolence, and the baneful effects of systematic bribery, have not had to be encountered.

The Electricity Supply Company of Spain may find that they have in their illuminating opponents formidable competitors, and competition may bring down together the prices of gas and electricity, and so reduce their estimated profits, whilst as regards the wiring and fittings, they will not have it all their own way. Other people are before them with fittings, the German, the Swiss, the French, besides our own Brush Company. The Sunbeam Company are also pushing lamps and fittings there. We believe the proposed plan of action of the Electricity Supply Company—although, of course, it may have been changed—was to canalise the leading thoroughfares with long mains, wire up and connect on the houses, and provide fittings, charging the tenants 5 centimes per lamp-hour, and crediting the landlords two of these centimes against the cost of wiring and fittings, and the maintenance of lights on landings until this amount was paid off, after which period the lights on his landings would be supplied free; the landlord has usually to provide such lights, the houses being as a general rule let in flats or apartments. Thus the five centimes dwindles to three, or to put it differently, the "fitments" would be given away. We trust this is not the large business in wiring and fittings to which, according to the prospectus, Don Pedro looks forward to swell the profits.

As regards the Electricity Company we are dealing with the future, and thinking of the value of its shares and debentures, which depend on its possibilities as a money-earning machine. But the child is father to the man, and we must not forget that £100,000 worth of capital has been already sunk, which as regards dividends must affect its after life. Freightage and customs duties into Spain are not light matters, and in that country the chance of receiving all that is due to you is a chance and not an absolute certainty. The present price for current may not always be obtained; and, notwithstanding that Madrid is not the whole of Spain, taking into view all the circumstances of the case, although we would rather hold debentures than shares, we cannot regard the former as of the thoroughly safe and sound character which we hope to be able yet to give to many an undertaking established to supply towns and cities with the electric light.

STORMS AND TELEGRAMS.

By W. SLINGO AND A. BROOKER.

(Continued from page 168).

It may not be out of place to pause for a moment in order to consider the enormous advantages which would follow the adoption of the suggestions contained at the end of the preceding article. For instance, suppose that Lowestoft were connected with London by underground wires (which would require the laying about 110 miles of new work), it would not then be possible for a storm of any magnitude, and however far-reaching, to isolate London from America and some of the more important continental stations; while if the damage were confined to England, communication could be maintained between London and the whole of the continent as well as the colonies and America. It is true that the number of lines, if worked as at present, would not be sufficient to cope with the whole of the ordinary international traffic; but it is not difficult, even under such circumstances, to arrange for the prompt disposal of extremely important messages, such as those concerning grave international or colonial matters, and so, perhaps, to prevent serious political complications. The above results would be obtained as follows:—From the place on the German coast, at which the cables land, there is already a length of underground to Emden, a most important station in North Germany, while on the other side, Emden has reliable underground communication with such important places as Berlin, Hamburg, and Bremen. From these stations, especially from Berlin, a number of lines radiate, many of them also being underground, so that the construction of the English section, above mentioned, would give London *certain* communication with many important continental towns, and render its isolation from all the important capitals, from India, South Africa, and Australia, highly improbable. The danger of risking this isolation, even for a day, is so apparent that we need hardly enlarge further upon the subject.

It may also be remarked that a cable from Emden passes through the straits of Dover and the English Channel, and, sweeping round Lands End, comes ashore at Valentia (in the south-west of Ireland), the landing place for a number of American cables; and this would afford one certain route for keeping London in touch with New York and North America generally. Among other important lines passing through Emden, those of the Indo-European Company may be specially mentioned. From Emden they run *viâ* Berlin and Warsaw to Odessa, and thence through the Crimean peninsula to Ekaterinoslav; then over the Caucasus to Tiflis, and so on to Teheran. This station is in good communication with India, the principal route running south through Ispahan and Shiraz to Bushire on the Persian Gulf, and then by cable to Kurrachee in North West India.

Underground lines to Dover would ensure connection with the French and Belgian Coasts and also with Denmark, since a Danish cable lands at Calais; while the 56 miles required to Beachy Head would ensure communication as far as Dieppe and Havre (which are at the ends of important French land lines) the latter being especially important since a cable forming part of the American system lands there.

Turning now to the question of underground inland lines, we find ourselves face to face with a task which affords far greater scope for the display of engineering skill. The problem is, of course, how to obtain the maximum of usefulness and reliability with the minimum expenditure.

In the first place, supposing it becomes necessary to work long stretches of underground wires, the question arises as to whether it is possible to overcome the objection that they can only be used in conjunction with apparatus worked by hand, or with Wheatstone automatic apparatus, working at the rate of about 40 words per minute. We believe that by the aid of repeaters, liberally and judiciously employed, and by a further development of the application of the shunted condenser this objection can be overcome. From experiments which we have at various times performed, we are convinced that on an underground wire between London and Brighton a speed of more than 400 words per minute could be easily maintained, while on similar wires between London and Bristol, Birmingham or Lowestoft, the working speed should certainly be not less than 250 per minute. This being so, the introduction of a repeater at Newbury, Towcester and Ipswich respectively should raise the speed to 400 words per minute or thereabouts. Of course, to obtain these rather startling results, it would be necessary that the highest skill in the arrangement and adjustment of the apparatus, &c., should be exercised. We mention Bristol specifically because of its really central position for the West of England, Wales, and Ireland. It may be remembered that in the 1886 collapse London was entirely cut off from Bristol, and communication had, with great difficulty, to be established *viâ* Oxford, Gloucester and Cardiff, *viâ* Southampton Yeovil and Exeter, and *viâ* Birmingham. Had a few underground wires to Bristol been available the traffic for Exeter, the Channel Islands, Plymouth, South Wales, and Ireland, could have been disposed of with comparative ease, assuming, of course, that the apparatus and its management had been equal to the occasion. Bristol also forms a common meeting point for six or seven of the foreign cable companies' wires. As examples of somewhat longer circuits, we might instance wires to such important centres as Liverpool and Manchester, which stations, each with repeaters at Rugby and Stafford, should be able to work to London at a speed of 250 words per minute, and similar results could be obtained between London and Leeds with repeaters at Bedford, Leicester and Chesterfield. The importance of these centres as possible transmitting stations under such a system can scarcely be overestimated. We believe that longer stretches than these would not prove advantageous, and that the Scotch traffic would be best served by a re-transmission at Manchester or Leeds.

We think we have said enough to demonstrate the enormous and hitherto unconceived possibilities of which the systematic establishment of underground lines is susceptible, but it may help to render the question simpler to non-technical minds if we add that the one underground line working at 250 words per minute would carry the same amount of traffic as six wires working key duplex. But there is no reason why duplex, or even quadruplex, working should not be practicable on such underground wires as we have been considering. All that is necessary to ensure good working for these systems is a line of high insulation steadily and uniformly maintained. The electrostatic capacity would be much greater than on an open line, but it, and the line resistance, would be steady and uniform, and that is all that is really required.

We have thus far confined our attention to a practical scheme for maintaining communication in the event of a total and general collapse of the overhead work. Such a collapse is, however, a very rare occurrence, and the vast majority of even the more serious breakdowns could be neutralised by the laying down of a number of underground trunk lines, leaving out altogether the question of repeaters, or even in such cases the necessity for employing them. It is a remarkable fact, and one worthy of the greatest consideration, that most of our storms are limited or confined to comparatively small areas; perhaps we ought rather to say, that the storms have generally some central line or belt along which they manifest the greatest energy. It is well known that the recent prolonged frost was more severe and more persistent in the south eastern counties of England than in any other portion of the kingdom, and although, so far as frost is concerned this may be regarded as an exceptional case, it is by no means exceptional for gales to be similarly confined. Those of our readers who are old enough to remember the storm of 1866 will probably remember also that it was most severe in the southern counties, and that it did comparatively little damage north of the metropolitan area. On that occasion instruments and clerks were despatched a few miles out to pick up the lines and work them from there to the northern stations. In 1876 a similar storm belt visited the Midland counties and did an immense amount of damage. On Saturday, January 26th, 1884, a very disastrous storm belt passed across the border between England and Scotland. The day had been a quiet one, and those on duty in the Central Office were composing themselves for the evening. It was known, however, that dirty weather had shown itself in the west; but the effect on the wires had been small and little danger was feared. At four o'clock in the afternoon all their calculations were upset, and one of the busiest evenings ever known set in. What the effect would have been had the day been any other than Saturday, is inconceivable. However, intimation was given that one of the nine Glasgow wires was stopped. No sooner had steps been taken to ascertain the locality of the stoppage than another and another gave out, and in a few minutes it became known that the whole of the trunk line on the Carlisle and Glasgow road, which carried seven wires to Glasgow, was down. Simultaneously the five wires on the Caledonian railway, between Carlisle and Beattock, gave way, leaving London without any communication with Scotland by the Western routes, and stopping also the Belfast wires (going *viâ* Carlisle and Stranraer). Such a catalogue was in itself sufficient evidence, were there no other, to indicate the existence of a terrific gale. While all this had been going on, the centre of the gale travelled across the country and eventually reached the east coast. Running through Newcastle were nine wires to Edinburgh, Dundee, Aberdeen and Glasgow, and these shared the fate of their fellows on the other side of the hilly ridge known as the Pennine Chain. Down they came wires, insulators and poles, some pulled out of the ground, some snapped off short at the ground, some broken in the middle and then hurled by the fury of the gale into the road or more generally into adjoining fields. In this way communication with Scotland was entirely stopped. Space will not permit a detailed review of all the stoppages, but a few comments on the general features of the breakdown may prove of service. One remarkable point worthy of observation is that the general nature of the breakdown indicates pretty clearly the direction and limits of the gale, its approximate force and the line of the greatest expenditure of energy. Previous to the commencement of the storm sleet fell heavily, but it soon gave place to snow. This on coming into contact with the wires froze on to them and enveloped them in heavy ropes of ice from two to four inches in diameter. Two or three days afterwards long tubes of ice were found on the ground under the wires, each tube having a longitudinal slit which had been made by the wire in thawing itself out. The belt was only about 25 miles broad, and passed from west to east, being bounded on the north by Ayr, Hawick and Alnwick, and on the south by Girvan, Dumfries and Morpeth. The comparative immunity subsequently shown to have been enjoyed by the wires north and south of this belt helped to define its limits. Among the laws of telegraph construction is one that requires the poles, where it is practicable, to be fixed, with reference to the prevailing winds, on the leeward side of the road, the object being that in the event of a storm breaking the wires or poles they shall fall into adjacent fields instead of blocking the road. Trees falling from the opposite or windward side of the road would also be less likely to reach the wires and drag them down, for falling trees are a prolific source of injury to telegraph wires, and no amount of care and forethought is sufficient to effectually guard against them. In one instance at Edgerston on the Newcastle-Jedburgh road, a large tree fell and knocked one double pole and all its fittings to pieces. At Langlee a tree 9 feet in girth broke off about 6 feet from the ground and turned a summersault over the line, only breaking one wire. While, however, trees did a deal of damage, the greater part of the injury resulted from the pressure of the wind upon the wires. Near Capheaton the line was wrecked for a distance of 35 to 40 pole-lengths, 15 poles being broken off short and many of the fittings smashed. Struts had been extensively provided, but they proved in this case to be quite useless. At Kirkwelpington, Horsley, and other places, very many double poles were smashed to pieces, breaking at various points between the ground line and 6 feet above. The breakdown on the Carlisle and Glasgow Road had much in common with what has been noticed on the Newcastle and Jedburgh Road, while on the Caledonian Railway the wires were torn down for miles by passing trains.

A fortnight or three weeks were spent in making reparations, but in the meantime, the maintenance of communication between Scotland and the South was a matter of the greatest difficulty. The first wire to Edinburgh was made up on the following Monday afternoon, but this channel was soon closed, and nothing more was done until the evening of the next day when another wire was got through. On Wednesday afternoon five or six wires were made up; some of them by utilising the good portions of several bad wires, the East Coast route being reported all through on Tuesday, February 12th.

Naturally, when considering the features of this storm, the thought arises that had there been an underground cable across the exposed district where this damage was done, the inconvenience would have been small indeed, and would have been confined to a few crosses, and possibly a few readjustments. The wires embraced in the area or zone under consideration are very susceptible to interruption, and next to the international circuits, would claim the first attention.

While we are on the subject of exposed situations, we may perhaps pause to thank Mr. Gilbert for the invitation conveyed in his letter which appeared in last week's REVIEW. We should be only too glad to accept it were it not that we are at present unable to get so far away. There can be no doubt that the A pole is a much better method of construction than either the single or the double pole method, even when struts are employed. With a vertical pole a strut is only effective on one side, and even then with a heavily-wired line, the bearing of the strut against the side of the pole, at a point below the wires, constitutes a fulcrum, and helps, with a strong wind, to make the pole kick its heels out of the ground, or to snap it off short. When the A pole is used, each inclined pole becomes a strut for the other, the fulcrum is at the top, and the result of a strong wind pressure is a tendency to make the pole bend inward. This is, however, prevented by firmly bracing the two poles together both below and above the ground level. Each horizontal arm constitutes also another strengthening element. The risk of one side of this rigid triangular construction kicking out of the ground, using the foot of the other pole as a bearer or pivot, is minimised by securing at the foot of each pole, and on the off side, a short pole-end, say three or four feet long, fixed at right angles with the pole. A line of A poles is possibly not very sightly, but when the number of wires is not too great, this method of construction is, to our mind, the strongest and best. When the line is heavily wired, H poles with four wires on each arm offer the greatest advantages, but the utmost care should be exercised in the bracing, owing to the fundamentally weak principle upon which the construction is based.

We are sorely tempted to draw a moral or two from the New York breakdown last month, but a limit must be put to these articles somewhere, or we shall exhaust the patience of our readers, to say nothing of the over-indulgent editors.

There is a danger that, considering what has already been said, it may be imagined that telegraph engineers have little to do except in times of severe atmospheric disturbance. Such a conception would be very wide of the mark, for there are several stoppages to record every day in the year from an almost infinite variety of causes and in all kinds of localities. Who, then, can say that a few underground lines if once laid down, would remain idle for many days together? On the other hand, how vastly important and useful they would prove were it possible to substitute a portion of an underground trunk line to make good a faulty section in an overhead line. On December 29th, 1890, a fire broke out at a shop in Woodbridge, near Colchester; a pole became involved in the flames, and the seven wires carried by it were stopped. These included four Continental wires going *viâ* Lowestoft, and very great inconvenience and some delay ensued. Again, on the 10th ult., the 18 wires of the same line were down between Stratford and Romford, and the traffic for East Anglia was consequently disorganised, the Continental traffic being also thrown more or less into confusion. Here, again, a few miles of reserve underground wires would have proved exceedingly beneficial.

(*To be continued.*)

MAJORITY OF THE TELEGRAPH SERVICE— A RETROSPECT.

WHAT, it may be asked, is the matter with our Post Office rejoicers? What has become of the willing hands and ready voices that swelled the success of recent municipal and official Jubilee celebrations? Has it to be said that they, as well as the section of Post Office commemoration stone layers, are under the spell of plethoric inertia? Heaven forbid! A fair opportunity for reasonable recognition, if not, strictly speaking, for jubilation has just passed away, apparently "unwept, unhonoured and unsung," and, like many of those more closely connected with the subject of these remarks, we are disposed to feel a sense of disappointment. Many of our readers may not be aware that on Thursday, February 5th inst., the Postal Telegraph Service attained its Governmental majority. In other words, it was on that date 21 years ago that the people of this country became the sole possessors of the inland systems of telegraphy, which had been floated originally by private capital and enterprise. Bought up at a price which is now considered to have been far in excess of their value, four companies surrendered their charters, materials, staffs, and individualisms to the representatives of the State, and the nucleus of the new department thus formed and concentrated, the new State baby was placed, so to speak, in the motherly lap of St. Martins-le-Grand officialism, and baptised with the name of "Postal Telegraph Service." The names of the four companies may be of some interest to our readers; they were called "The Electric and International," "The British and Irish Magnetic," "The London and Provincial," and "The United Kingdom Telegraph Company." Amongst telegraph engineers and clerks they were at that time, and are still spoken familiarly of as the "Elec.," "The London," "Mag," and "The U. K." The "Magnetic" company, with a telegraph system and code of its own, favoured the use of Bright's bell, and the "U. K." company, also with a system of its own, gave preference to the useful apparatus of Prof. Hughes. It may, therefore, be truly said that the infantine "Postal Telegraphs" came into the trammels of Government Service endowed with a wonderful heterogeneity of electrical and telegraphic apparatus. At that time these appliances were regarded with undisguised pleasure and admiration by those in the technical branches of the service.

No doubt all who have been witnesses of the gradual yet rapid march of improvement and invention in telegraphy and telegraph apparatus, will look upon their praises of things in 1870 as a theme to be utterly blotted out, but still it must not be forgotten that the ponderous double needles, noisy embossers, uncertain and exasperating single needles, rattling bells, and chattering "Hughes'," to say nothing of clumsy switches and awkward keys, were at least in their day equal to the demands made upon them, and in fact were the pioneers of the system as it is known to day in this and other countries.

The attachment of the telegraph service to the Post Office, and its amenability to post office administration, are points on which it it is considered by some that serious mistakes were made; however, that may be, it certainly does not seem that the Telegraph Service is altogether proud of its kinship, and it is equally in evidence that Post Office higher officials, pure and simple, are regarded as being very jealous of the more general application of telegraphy to the service of the masses.

The eyes of the nation cannot be closed to the fact that the system of wetnursing adopted by the Post Office authorities in the case of the telegraph service has not been one of uniform success, and it may be that that service has been regarded somewhat in the light in which Joseph was regarded by his envious brethren, just about the time he made his unpromising journey into Egypt.

Shortly after the transaction of Saturday, February 5th, 1870, now known as the "Transfer," took place, there began a general process of improvement in communication—the nursling had to part with many of its playthings—under the advice and direction of the electrical authorities of the department, and a very important and august body they were. A steady elimination began, not of the "innocents" but of the "ancients." Our old friend "Double-needle," with his open and almost smiling face, had to make an instantaneous and unceremonious exit. Certainly one or two were kept just to remind the newer apparatus of what their inevitable fate would be. It stood for nothing that some operators could read 60 messages per hour off his double face. His room was preferred to his company. We remember one standing for years in the Central Telegraph Department; it was relegated in its old age to an easy job, being joined up with Buckingham Palace, almost an unused circuit.

Then came the turn of the familiar if somewhat clumsy "embosser"; we never heard of anyone even keeping a piece of embossed slip as a relic, so it may be said the embossers made their exodus practically unregretted. About this time the old fashioned double current Morse keys with very high play and hugh switches, shared the lot of their exiled brethren and retired to the obscurity, if not the oblivion, of the workshop and stores. Bright's bell, an instrument the removal of which occasioned some surprise amongst the telegraph staff, was then practically withdrawn from the service, though a few remained in different offices, probably more as a means to make use of the limited staff than anything that consideration of its past honourable and extremely useful career had inspired. It must be remembered that the "magnetic" bell code was peculiarly well adapted to "bell" working, and apart from technical questions, Bright's bell was as fast an apparatus as any since introduced. It will of course be understood that we except Wheatstone's automatic, and are speaking only of hand or key working apparatus.

Notwithstanding its undoubted speed under the "magnetic" code, substantial technical, and pecuniary objections led to Bright's bell being placed in the march to the rear, to the deep regret of the magnetic code workers, who, as a body, it must be said, were extremely efficient hands.

In 1872 the first great agitation of a neglected staff culminated in a series of strikes throughout the United Kingdom and Ireland. The unfulfilled promises of the Government were no doubt the direct cause of this unfortunate *émeute* which resulted in an immediate, but entirely inadequate, improvement in the position of the telegraph staff.

About this time, 1873, a great stride was made in telegraphy by the introduction of Stearn's duplex system, a great saving in cable plant being one of the natural results attending this system, which permits of the simultaneous discharge of two opposing currents on a single line. The practical effect of this system being, as no doubt our readers are aware, to double the ordinary commercial capacity of a single wire. The "U. K." Hughes instruments hung on for a number of years, but they, too, disappeared about 1876. Early in 1874 a change of quarters was made from the cramped and cooped up central premises in Telegraph Street to the present handsome *locale* in St. Martin's-le-Grand. The premises in Telegraph Street were by no means small, but they became, through increase of business and also of staff, altogether inadequate to the immediate requirements of the service.

The staff were at this time in a state of great excitement with regard to the deliberations of the Civil Service Commission which sat under the presidency of Dr. Lyon Playfair. Recommendations, which it was confidently anticipated were intended to benefit telegraph clerks, were on the eve of being applied, so said the busy tongue of rumour, But these cherished hopes were doomed to bitter disappointment, and the staff were allowed to witness the application of new scales of pay to neighbouring departments, whilst they pursued the even tenour of their neglected, forlorn and hopeless course. No one under these circumstances will feel surprised that 1880-81 were years of danger to the department. Mr. Fawcett's death appears to have occurred before he had fully dealt with remedial measures for the too long neglected junior department of the Post Office, but he to some extent allayed dissatisfaction. Certainly the history of the postal telegraph clerks has been an unhappy one, and it is quite evident that all they have wrung from the post office and the treasury is due to their own unshaken pertinacity and resolution.

Regarded, in 1874, by most people as a veritable wilderness, ten years of progress and extension found the huge St. Martins-le-Grand building in the same predicament as its predecessor in Telegraph Street, and the construction of a new storey became an imperative necessity; this vast addition was made, and the necessary transfer of many miles of "leads" effected without the telegraphic operations in the old storey being retarded for a single hour. The scene on the top of the building during the construction of the extra floor was certainly one of the sights of London during 1883-4.

Another great improvement in practical telegraphy was the introduction of the quadruplex system into the Government service, about 1878. Like most other inventions and improvements it took some little time to establish the reliability of quadruplex working; but on good steady wires the results of the system are of great advantage to the department, giving, generally speaking, the same results as four single lines of communication.

The most recent innovation has been the application of Delaney's Synchronous or Multiplex system, to the telegraphic *savant* perhaps the most beautiful theory of all, and a system which may eventually supersede those which in themselves are comparatively new.

(*To be continued.*)

PRACTICAL SUGGESTIONS TO ELECTRIC LIGHT WIREMEN.

By ELMER E. WARNER.

(ABSTRACT.)

If you are a superintendent of installation for a concern that understands its business you will estimate, or at least as far as practicable figure the amount of wire and material requisite to instal on the conditions of all submitted specifications. You will be posted as far as possible from the start on the nature of the contract which your company seeks to secure. If you get it your data will enable you to order from the stock or a dealer all the material needed for the execution of the contract. If there is likely to be much extra work, as is often the case, you had better put the matter squarely before the purchaser and have a supplemental contract drawn up at once to cover it. This will save him much annoyance and expense, and will avert the necessity of pulling down work or making changes of plans so vexatious to the thorough engineer, who puts things up to stay. Make plain sketches of the main and circuit distribution finally determined on, using symbols understood by all your foremen. When the building is ready for wiring pick the man you mean to put in charge of it, put your plans in his hands; if convenient, go over the building with him and introduce him to the architect or owner's representative, and give him a copy of the insurance rules and contract under which he is to work. Give him time sheets and a memorandum pad and insist on a weekly report of the progress of the work. See that all material is on hand or promptly forwarded. Provide a chest or lockers in which it can be safely stored. A very useful locker may be made which is hinged near the centre and provided with shelves, so that when set on end and open, it gives practically two cupboards in which to assort and store small material. Let your foreman pick his own men, only holding yourself as a higher tribunal to which any dissatisfied employé may appeal and by whom the rate of pay on recommendation of the foreman must be decided.

When you have done all this go away and leave your foreman alone. If you havn't confidence enough in him to do this you had better discharge him and get somebody else. If you are at all the man for your place you will soon learn to know your man and establish a confidential and mutually helpful relation with him; you will not stultify him, but stimulate by the sense of exclusive responsibility which you impose. Just go away and attend to other business. When it comes to the erection of dynamos, engines and switchboard, and to the testing and starting of the plant, it will be well to give a little personal supervision.

Now as to the foreman. Let me hope that you will not abuse your authority. Be as democratic as you can with your workmen. Decide by vote the time of starting work and length of noon hour so as to suit the majority. Remember you are not the figurehead of the company; you are hired to work right along with your men and you ought to get from 25 to 50 cents a day more than the best man under you for supervising. If your company does not understand this explain it to them. Always keep a bright boy in the gang if you can to fill in gaps and learn the business. Hire no man as wireman who has not his full kit of tools. Your company will purchase all the tools desired by workmen, and furnish them at cost. See that the tools are kept in good condition.

Try to get your wiremen to provide themselves with belts carrying pockets for screws, porcelains, cleats, &c., and with wire bent as holders for screwdriver, plyers, awl, or such tools as happen to be in constant use on the particular job. More time is wasted, I have noticed, in climbing up and down step ladders for things fallen or forgotten or in fumbling for them in the depths of hip pockets or blouses than in doing the work itself. Of course you can't design a belt that is perfectly adapted to all classes of work but you can make one of great general utility; one that will pay for itself in two weeks' use. See that your company provides reels and carriers for wire, particularly the larger sizes; they can be made to fold up and very cheaply, so there is no excuse for tangling and kinking wire or rolling it all over the floor.

Take one of your broken bamboo fish poles and stick a piece of chalk in the end. When the location of outlets on ceilings is indefinite in your plans, get the owner or his representative to mark them directly on the ceiling with your pointer. This will save you from the disagreeable necessity of believing him a liar in case of misunderstandings. It is a good plan to lay out exposed work for your own men in this way, and if you will only bend a small brass tube and clamp it on the bamboo near the chalk, you'll have a pair of dividers with which you can step or space off distances from side walls or between lamps with the greatest ease and accuracy. Add a few foot marks on the bamboo and you will have a very convenient measuring stick for getting drop of pendants, fixtures, &c. These are but a few suggestions among those that come, I am sure, to all of us who are anxious to systematise and to perfect our business and to instal the electric light so satisfactorily that no objection of unsightliness or of danger can be urged against it, and so cheaply as to bring its purity and brightness into the poorest workmen's houses.—*Electrical World.*

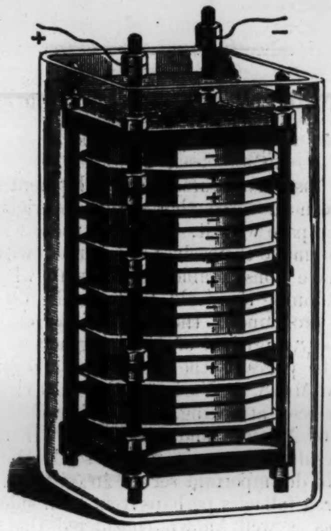
THE "ATLAS" ACCUMULATOR.

[COMMUNICATED.]

THE "Atlas" accumulator, presented by M. R. V. Picou to the Société Internationale des Electriciens at its last sitting, is the result of the combined endeavours of Messrs. Carl Hering, of Philadelphia, Abdank Abakanowicz, D'Arsonval and Picou.

It is composed, as shown in the accompanying figure, of a series of positive and negative elements placed one upon the other alternately, whereas in most other accumulators the positive and negative plates are arranged vertically. Each of these plates is formed of two rectangular blocks with rounded corners, and pierced with a great number of holes. These blocks of porous lead or peroxide of lead, present considerable solidity, notwithstanding their porosity and their low density. The current is conveyed to these blocks through a sheet of lead, in such a manner that the accumulator may be compared to a pile of black and white sandwiches, placed alternately, in which the ham would be represented by a thin plate of lead, a thin sheet of perforated celluloid separating the alternate sandwiches of contrary natures. The current is brought to the blocks of active material by the plates of lead, which are fixed alternately on opposite sides of two rods of antimony-lead alloy, these rods being provided with screw threads and screws which keep in position the corners of the plates of lead, holding them firmly, and thus ensuring good contacts. Two conducting bolts of antimony-lead alloy, and two ebonite bolts, ensure the rigidity of the whole apparatus by exercising a pressure on two perforated plates of ebonite placed at the top and bottom of the accumulator.

By this arrangement we employ for the positive and negative electrodes a composition which is homogeneous, and which conducts throughout its mass. The mounting, moreover, gives fixity to the whole, and facilitates inspection, examination, and, when necessary, the renewal of the plates. The most characteristic point about this new type of accumulator is undoubtedly its great specific lightness, for from it we can obtain a quantity of from 12 to 20 ampère-hours per kilogramme of plates, according to the rate of discharge adopted, a result above the present industrial average. The rate of discharge varies with the thickness of the active blocks. The thick blocks are 14 millimetres thick, and are suitable for outputs of less than 1 ampère per kilogramme. The thin blocks are only 8 millimetres thick, and the output can then amount to two, or even three ampères, per kilogramme.



Whatever may be the thickness of the blocks, the arrangement adopted reduces the ratio of the inert matter to the active matter, and allows of the free dilatation of the plates, which cannot undergo any change of form, notwithstanding the variations in volume produced at various stages of the charge and discharge.

As regards the rate of charge, M. Picou has abstained from giving any definite values of output, and he has, on the contrary, dwelt on the want of foundation for this indication from an industrial point of view. In M. Picou's opinion, accumulators should not be charged at a certain intensity or at a constant intensity, but at a *constant potential*. His own experiments have not been sufficiently numerous for him to quote figures; but he hopes that some member of the Society will complete the indications on this point by giving the results of their personal experience.

M. Hospitalier supports M. Picou's view, by summing up the results of experiments made at the School of Industrial Physics and Chemistry at Paris, by Messrs. Chevalot and Delarivière, pupils of the third year at the school. These experiments related to a Gadot accumulator containing 9·5 kilogrammes of plates and charged alternately at a constant intensity (10 ampères) and at a constant potential (2·3 volts).

In the two cases, the renderings in quantity (ampère-hours) and in energy (watt-hours), are to all intents equivalent, the discharges being effected in both cases over a constant resistance; and the discharge being stopped when the difference of potential at the terminals fell to 1·8 volts, but the charge at a constant potential presents a special interest from the point of view of the rapidity of the charge and of the nature of the machine to be employed.

At a constant potential we can, in the first hour, adopting the value of 2·3 volts per element, put into the accumulator 50 per cent. of its total capacity, and 75 per cent. in two hours, the charge being completed in less than five hours, without there having been any necessity to exceed a potential of 2·3 volts per element. The charge at a constant current requires from 8 to 10 hours, with a difference of potential amounting to 2·5 volts per element at the end of the charge.

The shunt dynamos generally used for industrial purposes being calculated to furnish a constant difference of potential rather than a constant intensity, are well adapted to the system of charging advocated by M. Picou, and it is probable that his paper will have the practical result of causing the statement of the rate of charge to disappear from the catalogues of makers of accumulators, the statement of the potential of charge being substituted for it with much greater advantage.

ELECTRICITY, ETHER, AND MATTER.

By J. GRAY, B.Sc.

WITHIN the last few years the development of electrical theory has been so rapid that many electricians have been unable to keep pace with it. Some of those who have taken the trouble to make themselves acquainted with the modern views, still have considerable doubt as to whether they are right in abandoning their old faith; while others have unhesitatingly pronounced the conclusions of the modern theorists to be "a product of the imagination." Mr. J. T. Sprague, in the pages of the *Electrician*, and of the *English Mechanic*, and Mr. S. A. Varley in the ELECTRICAL REVIEW, have recently been attacking, with their well known ability, the theories of Maxwell and his school. If the discussion which has resulted does not finally settle the questions in dispute, it will do important service in ventilating the subject and eliminating fallacies perhaps from both sides.

Maxwell, as is well known, considered that the medium which transmits electrical energy was identical with that which transmits light. This medium—the so-called luminiferous ether—it is now generally admitted, must be something different from Matter, using for convenience the term Matter to comprise only the elements of the chemist. The evidence for the existence of the luminiferous ether, rests on the necessity for having in interstellar space, where sufficient Matter does not exist, a medium which has sufficient mass and rigidity to transmit the energy of light. The amount of energy produced per minute by direct sunlight falling on a square centimetre has been measured by Pouillet. From this, by dividing by the velocity of light the quantity of energy in a cubic centimetre can be calculated. By the law of inverse squares, the energy per unit volume near the sun, is found to be 1·886 ergs. According to the undulatory theory of light, this energy is in the form of wave motion, and if we assume with Sir W. Thomson that the amplitude of a wave is not more than $\frac{1}{100}$th part of the wave length, the coefficient of rigidity, and the density of the ether can be easily calculated. The coefficient of rigidity comes out to be 842·8, and the density $9{\cdot}36 \times 10^{-19}$. The density of the air, at the same distance from the earth, would be 3×10^{-346} or 3×10^{327} less than that necessary for the ether, and, beside, we have no evidence that the air is capable of transmitting transverse waves. The coefficient of rigidity of the ether given above may be compared with that of steel, which is 8×10^{11}, or glass which is $2{\cdot}4 \times 10^{11}$.*

The question which next arises is, what evidence do we possess that the luminiferous ether is identical with the medium which transmits electrical oscillations? Evidently, if the velocity with which electrical oscillations are transmitted is the same as the velocity of light, the probability is immensely in favour of the mediums being identical, since the velocity with which a wave is transmitted depends on the ratio of the rigidity to the density. The experiments of Hertz and Lodge have shown that these two velocities are approximately the same.† Hertz converted the electrical oscillations, excited by an induction coil and an oscillator, into stationary waves by reflection from a sheet of zinc placed at a suitable distance. The length of the wave was then measured by moving a secondary circuit about between the primary oscillator and the reflector until the positions of the places of maximum and minimum disturbance were determined. The wave length and the number of oscillations per second being known, the velocity of propagation could easily be calculated.

One of the most revolutionary conclusions of the modern school is, that the electric energy is not transmitted from the source to the work through the so-called conductor, but through the dielectric medium intervening between the source and the work. This theory was given by Prof. Poynting in 1884, as a necessary development of Maxwell's theory that the electric energy resides in the dielectric medium.* As this theory is of great interest and seems to be by no means clearly understood by some of the writers on the Ether question, I shall attempt to give some account of it, though possibly only in a very crude way.

The electric field, due to a static charge, can be divided up into cells, each containing one unit of energy, by the intersection of unit equipotential surfaces with unit tubes of force. A simple and practical method of representing this structure of the electric field has already been described in the pages of the †ELECTRICAL REVIEW. A unit tube of force is represented as an elastic tube, the area of any section of which contains unit quantity of electricity. These tubes are divided up into unit cells by transverse elastic diaphragms which coincide with equipotential surfaces rising one above the next by one unit of potential. The cells are supposed to be filled with an incompressible fluid, and the elastic diaphragms are distorted more or less, according to their position in the field and according as more or less of the incompressible fluid (which is taken to represent electricity) is forced into the terminal cell of a tube of force. If these tubes of force are represented by lines of force, corresponding to their centre lines, it is easy to deduce from this model of the electric field Maxwell's proposition, that in order to account for attraction and repulsion in the electric field, the lines of force must tend to shorten themselves, and must exert an outward pressure at right angles. The pressure of the fluid in a cell represents the potential, and the stretch on any diaphragm the electric force at any given place.

With the help of this model we can form a tolerably clear idea of the nature of Poynting's theory. Taking first the case of the Leyden jar, or Condenser; fig. 1 represents a section of two conducting plates, A and B, one charged with positive electricity and the other negative, the space between the two being occupied by a dielectric such as air. The fine lines represent the traces of equipotential surfaces on the plane of the paper. The lines of force are not drawn on the diagram, but they can be easily imagined by remembering that they run everywhere at right angles to the equipotential lines. If the positive charge is on A, the lines of force proceed outward from A on every side; thus parallel lines of force pass across from A to B through the space between the two plates, while in the space outside they pass from A to B in paths intersecting the equipotential lines everywhere at right angles. The line, C, may be taken to represent one of these external lines of force.

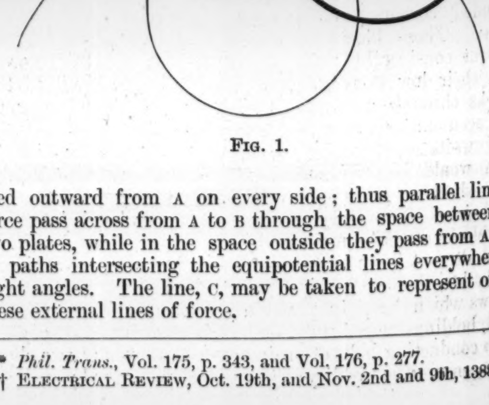


FIG. 1.

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* *Encyc. Brit.*, article "Ether."

† Lodge's "Modern Views of Electricity," pp. 237, 244.

* *Phil. Trans.*, Vol. 175, p. 343, and Vol. 176, p. 277.

† ELECTRICAL REVIEW, Oct. 19th, and Nov. 2nd and 9th, 1388.

The energy of the electric field may be considered to have been stored in the first place in the dielectric between the plates A and B, but part of it has now been transferred to the external electric field. By far the greater part of the energy, however, still remains between the plates A and B, for it is evident that by far the greater number of the cells which would be formed by drawing the lines of force would lie between A and B.

Consider now what will take place if the plates are connected by a conductor, C. For simplicity the conductor will be taken to lie along a line of force, and to be of so great resistance that the position of the equi-potential lines will not be perceptibly disturbed when the current is flowing. The essential difference between a conductor and a dielectric is that the former offers little or no elastic resistance to the flow of electricity, or may be looked upon as incapable of sustaining a stress in the electric field. Connecting the two plates of the condenser by a conductor, may be looked upon as analogous to what takes place when the chain of a watch breaks while the mainspring is wound up; the energy stored up in the coiled mainspring is given out to the barrel, and if a brake were pressed on the barrel with the proper force the whole of the energy of the spring would be converted into heat. In a precisely analogous way the energy on the strained dielectric is converted into heat in the conductor. In the first place, the energy in the external field nearest to the conductor will be used up, or, more strictly speaking, transformed. This will then draw a fresh supply from the reservoir of energy between the plates A and B, and so on till the whole of the energy in the electric field is given up to the conductor.

The important question now arises, what path does the energy follow in passing from the source of energy to the conductor. Poynting's theory is that the electric energy moves at any point in a direction perpendicular to a plane containing the electric and magnetic lines of force at that point. As the magnetic lines of force are circles, the centres of which lie in the conductor, the plane in question will be tangent to the circular line of force passing through the given point, and the perpendicular path in which the energy flows will be tangent to the equi-potential plane passing through the point, and will be directed towards the conductor. This may be stated shortly by saying that the energy moves at each point along the equi-potential surface passing through the point, and in a direction towards the conductor, where the energy is being dissipated or transformed, and away from the source where the energy is being generated. In fig. 1, when the circuit is complete, the energy will flow out from the source, namely, the dielectric between the plates A and B, between the unit equi-potential lines, and enter the conductor, C, everywhere in paths perpendicular to its axis. The energy is supposed to travel in the form of wave motion. Any strained elastic body, such as a spring, when suddenly released from stress at one end, is thrown into a state of vibration; and thus it would appear that the energy will be transferred from the source to the external circuit by a series of transverse waves flowing everywhere along equi-potential surfaces into the conductor.

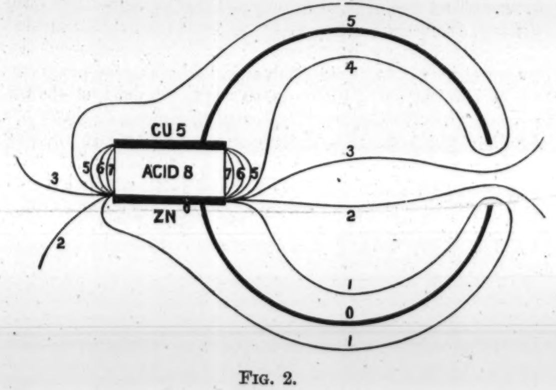

FIG. 2.

The state of the electric field, and the flow of electric energy in the case of the voltaic cell will now be described. In fig. 2, the state of the field before the external circuit is completed, is shown by unit equi-potential lines. It is assumed that the total rise of potential (taken as 8) takes place at the surface between the acid and the zinc; hence the whole of the equi-potential lines pass out from this surface. At the surface between the acid and the copper plate there is a back E.M.F. of say 3; and this reduces the potential of the copper plate and the part of the conductor attached to it to 5. In consequence of what has been said above, it will be evident that the equipotential lines, 7, 6, and 5, converge upon the surface between the acid and the copper. Lines 4 and 1 pass round the open ends of the conductor, and the other lines lie approximately as shown in the diagram. It will be observed that almost the whole of the effective E.M.F. between the copper and the zinc, namely, 5 units, is concentrated upon the thin layer of dielectric between the ends of the conductor, and as this layer is gradually reduced by the approach of the ends of the conductor, the equipotential line 4 approaches and becomes merged in the conductor, and the other lines approach the positions shown in fig. 3, which they finally take up when the circuit is completed.

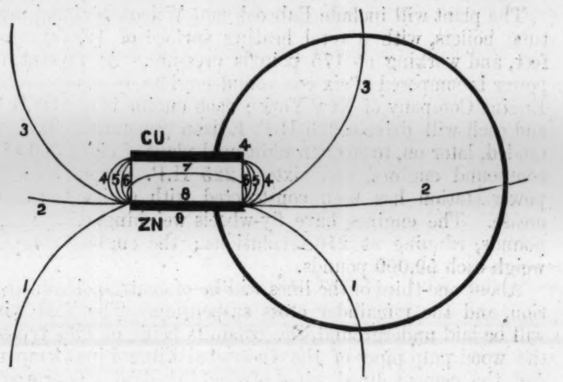

FIG. 3.

The electric energy now flows from the surrounding dielectric into the line of weakness represented by the conducting circuit in a succession of transverse waves. The difference, however, between this case and that of the condenser, illustrated in fig. 1, is that the wave energy is continuously supplied, as fast as it is drawn off, by the chemical combination of the atoms of the acid and the zinc, while in the case of the condenser, the supply of wave energy ceased as soon as the strain in the dielectric between the plates had disappeared. Poynting shows that the rate at which energy flows out between any pair of equipotential surfaces is proportional to the difference of potential between the surfaces; hence, if V_1 be the total E.M.F. at the surface of the acid and zinc, and V_2 the E.M.F. between the copper and acid,

$$\frac{V_1 - V_2}{V_1} = \frac{\text{energy transformed in circuit}}{\text{total energy generated}}.$$

When the resistance of the internal circuit is uniform, as in the case illustrated in fig. 3, the unit equipotential lines intersect the conductor at equal distances; this, however, is not the case if the resistance at different parts of the external circuit varies per unit of length.

When there is an electromotor in the external circuit, there is a counter E.M.F. at the place where the motor is working, and the effect on the electric field is similar to that of the surface between the copper and the acid in fig. 3. A number of the equipotential lines converge on the motor equal to the counter E.M.F. generated by the motor, which number becomes nearer and nearer equal to the total number diverging from the generator or source as the E.M.F. of the motor approximates to that of the generator. In the theoretical case when the two E.M.F.'s are equal, all the equipotential lines diverging from the generator converge on the motor, and, therefore, no energy flows into the conductor; that is to say, no heat is produced and there is no current. The formula for the efficiency of the motor is the same as that deduced above for the similar case of the voltaic cell; and this agrees with the formula which has been deduced in this case from Ohm's law.

This is important as showing that the numerical results deduced from the new theory of the electric current are in perfect agreement with the established laws of the old theory.

(To be continued.)

THE BUFFALO ELECTRIC RAILWAY.

THE *Electrical Engineer* of New York, in its issue of January 28th, contains some account of the installation, now in progress, connected with the application of electric motive power to some portion of the tramway systems in the city of Buffalo. The syndicate, which controls this enterprise, represents the consolidation of all the street railways in Buffalo, comprising between 400 and 500 miles of lines.

The electric railway system will consist of about 53 miles of double (or 106 miles of single) track, and will have a carriage service of 300 cars, described as 32 and 34 foot 8-wheeled vestibuled cars.

The plant will include Babcock and Wilcox sectional water tube boilers, with a total heating surface of 12,000 square feet, and working at 175 pounds pressure. At present, the power is composed of six compound engines, made by the Ball Engine Company of New York; each engine is of 250 H.P., and each will drive a 225 H.P. Edison generator. It is intended, later on, to erect an additional plant of eight 300 H.P. compound engines, and sixteen 225 H.P. generators; the power station has been constructed with a view to this increase. The engines have fly-wheels weighing each 15,000 pounds, running at 210 revolutions; the engines complete weigh each 50,000 pounds.

About one-third of the lines will be of centre-pole construction, and the remainder cross suspension. The feed wires will be laid underground, the conduits being of two types—the wood pulp pipes of the Indurated Fibre Pipe Company, and the cement lined pipes of the Standard Underground Company. These conduits consist of from two to eight pipes each, 2½ to 3 inches inside diameter. The feed wires are jute and lead covered cables, and are connected up to the trolley wires at every eight poles, or at about every 1,000 feet. Manholes are located at 380 feet apart, and it has been arranged that all joints are placed at them. In the first installation of 15 miles of double track, there are about 10 miles of conduits, in which will be placed some 40 miles of No. 0000 cable, and 25 miles of feed wires of No. 000, in addition to the overhead conductors.

In the track work, 56 and 60 lb. girder rails, with grooved tread, are used, with heavy Georgia pine ties placed 2½ feet between centres. The pavements are principally of asphalte, and here the rails are spiked directly to the ties, chairs being omitted.

All the construction work, including buildings, power plant, with the steam and electrical equipment, line erection, and conduits, has been executed under the direction of the Field Engineering Company of New York, who are acting as engineers and contractors for the Buffalo Street Railway Company.

POSTHUMOUS SCIENTIFIC HONOURS.

By S. ALFRED VARLEY.

THE name of William Sturgeon has lately been very prominently brought forward through the medium of the Cantor lectures on the "Electro-Magnet," delivered by Dr. Silvanus Thompson at the Society of Arts last year, and the concluding portion of these lectures brought to my mind the fact that I once had the good fortune to see Mr. Sturgeon. In 1850, "The Researches of Sturgeon," embodying the chief scientific labours of his life, were published in a single volume, and immediately after the book was out of press, Mr. Sturgeon called upon my father, the late Cornelius Varley, to ask him to accept the first copy issued, as a slight recognition of services rendered at what was a turning-point in Mr. Sturgeon's life. My father had not seen Mr. Sturgeon for a space of over 20 years, and the meeting between the old artillery soldier and my father in 1850 was a pleasant one to both of them—especially pleasing to my father it was to find that the services it had been his privilege to render had not been forgotten, and very pleasing also that Mr. Sturgeon should have been anxious that the first copy of the crowning literary labours of his life should be presented to my father.

I was reading a few days since the following passage:—"I had rather that one fading bud of kindly sympathy were laid in the palm of my living hand, than that my coffin were shadowed by a pyramid of the costliest exotics that ever burdened with sickly fragrance the chamber of death," and I am of opinion that the hard-working soldier who successfully carved his own way in life would have sympathised with what is expressed in the passage quoted.

In attributing the discovery of the electro-magnet so exclusively to William Sturgeon as Dr. Silvanus Thompson has done, a false impression is given of the history of electro-magnetism, and it is contended that injustice is done to other scientific discoverers.

The numerous references to articles in the *Philosophical Magazine* and other scientific journals which accompany the published report of Dr. Thompson's late Cantor lectures, give evidence of industrious research; and, therefore, it seems difficult to understand how it is that a communication from Mr. Hatchett, which appears in the *Philosophical Magazine* of January, 1821, and which is headed "Electro-magnetic Experiments of Oersted and Ampère should seem somehow to have escaped attention. In the communication referred to it is stated that "M. Arago magnetised a slip of iron and afterwards a steel wire by putting them in contact with the conjunctive wire (*i.e.*, the conductor closing the voltaic circuit). "A simple method of magnetising a steel needle by the conjunctive wire, consists in placing the needle in the part of the conjunctive wire which is *twisted spirally* (the italics are the writer's). Whether the needle is placed directly upon the threads of the spiral or enveloped in paper or a glass tube to prevent contact with the conjunctive wire, it becomes magnetised and its north and south poles corresponding to the north and south poles of the terrestrial magnet, will be determined by the direction of the spiral which bears the needle." In another passage in the same communication it is stated that "M. Arago, following the theory of M. Ampère, conceived the idea of twisting a conjunctive wire in the manner of two symmetrical spirals placed one after the other—these spirals differed from each other only as to the direction in which their generating points turned round their hollow spindles; by putting a needle in each spiral the two needles became magnetised at the same time, so that the poles of the same name were contiguous. In transmitting a discharge of a Leyden phial through a copper wire twisted in the same manner of two consecutive spirals, M. Arago has further observed that the steel needles placed in these spirals became magnetised by the electric fluids of ordinary machines as well as by the voltaic apparatus.

"Other facts have been long known which prove the mutual influence of the two fluids, magnetic and electric. The points of the paratonnerres become naturally magnetised by the electricity of the atmospheric air. M. Arago, in the annuary of January of 1819, states that a Genoese ship on its way to Marseilles was struck by the thunder at a little distance from Algiers; that the needles made a half revolution although the needles did not appear damaged, and the ship struck on the coast at the moment the pilot thought he made the North Cape." In another part of the communication quoted, Mr. Hatchett says "that Oersted showed that the magnetic effects of the electric current depended solely upon the quantity" of the current, and he enters into details showing how Oersted demonstrated that this was so.

The above communication of Mr. Hatchet, published in January, 1821, deserves to be reproduced in its entirety, for it really gives a more complete scientific description of the electro-magnet than is contained in Sturgeon's communication to the Society of Arts, of 1825, four years later, and it seems curious that so painstaking a searcher into the records of scientific history as Dr. Thompson should have somehow or other have overlooked Mr. Hatchett's article.

In March, 1822, Peter Barlow describes the star wheel electromotor, and mentions Marsh's name very favourably, crediting him with original work, and regretting that he was not in a position where his abilities would receive a higher pecuniary recognition.

A Dr. Kraemtz writes to the *Phil. Magazine*, in 1823, "Immediately after Oersted's discovery, the idea occurred to Prof. Schweigger of increasing the electro-magnetic power by winding the connecting wire of the voltaic battery round the compass-needle, so it will be seen that really a great deal was known in respect to electo-magnetism before the year 1825.

In 1823 Mr. Marsh was awarded the large silver medal of the Society of Arts and a purse of 30 guineas, for his portable electro-magnetic apparatus, and in 1825 Mr. Sturgeon received a similar reward from the Society of Arts for certain advances on Marsh's apparatus.

The following passages relating to the apparatus of Marsh's appear in the Society's proceedings of 1823, written, it is presumed, by the secretary, the late Mr. Aikin :—"Exceedingly interesting and important experiments on the intimate connection between electricity and magnetism mark the principal track of philosophical investigation during the last four years. Prof. Oersted, of Copenhagen, led the way, and was followed with zealous emulation by Ampère, Biot, Arago, in France; by Sir H. Davy, Dr. Wollaston, Prof. Cumming, and Mr. Faraday, and Mr. Barlow in England. The large and costly apparatus employed by most of these philosophers necessarily restricted to a few persons placed in singularly favourable circumstances the prosecution of these discoveries."

"Mr. Marsh, occupying a very subordinate department in the Royal Laboratory at Woolwich, was employed by Mr. Barlow as an assistant in his electro-magnetic experiments, and thus favourably circumstanced, he was induced to turn his attention to the construction of an apparatus capable of exhibiting all the known facts of electro-magnetism, and of enabling the possessor to prosecute further researches in this interesting and important branch of natural philosophy."

"Having succeeded in his object, Mr. Marsh submitted to the inspection and judgment of the Society his apparatus, and before two numerous committees exhibited by means of it, with perfect success, all the facts of electro-magnetism which at that time had been discovered."

From the official description of Sturgeon's apparatus, contained in the Society of Arts Proceedings of 1825, it would appear not to have attracted so much attention as that of Marsh's, which preceded it. The opening passage reads as follows :—

"Mr. Marsh's apparatus for the same purpose as Mr. Sturgeon's was rewarded by the Society in the session before last, the battery consisting of plates presenting eight surfaces of about a square foot each, was the smallest that had at that time been applied to electro-magnetic researches; the rest of his apparatus was such as had already been used by Ampère, Davy, Barlow, Faraday, and others."

"Mr. Sturgeon's apparatus is even more portable than Mr. Marsh's, and is better fitted than that, for the use of the lecturer." Sturgeon's battery is then described as being similar to Prof. Hare's calorimotor, and it is added "that Mr. Sturgeon has very judiciously chosen to have *small* galvanic power assisted by *strong* magnetic power (the italics are the writer's), rather than the reverse, as is usually the case; this has enabled him to economise the size of the battery, whilst the increased magnetic power is obtained at a small first expense, and needs no renewing."

Mr. Sturgeon's letter to the secretary of the Society of Arts, when submitting his apparatus and bringing it under the notice of the Society makes no reference whatever to the electro-magnet, and neither do the three certificates of Profs. Christie, Gregory, and Mr. Barlow, annexed to Sturgeon's communication, make any mention of it. The chief claims put forward are the substitution of powerful magnetic force for that of large battery surface, and also the superiority, on account of its larger size, of Sturgeon's apparatus over that of Marsh's for lecture purposes.

The electro-magnet forms part of Sturgeon's apparatus of 1825, and is described without comment in the same way as the rest of the apparatus, but Mr. Sturgeon would seem to have been the first to make a horseshoe electro-magnet, and to point out its power to lift a considerable weight. Dr. Silvanus Thompson states that the electro-magnet forming part of Sturgeon's apparatus rewarded by the Society of Arts lifted 9 lbs.

Now, it can be of no possible benefit to those who have passed away whether they be praised or blamed by those who come after them, but the history of scientific advances is of value to the living if *it be true* history, and Dr. Silvanus Thompson seems to have dealt with the claims of Sturgeon too much in the same way as a barrister does when defending a client. As an example of this, Dr. Thompson, when describing the original horseshoe magnet of Sturgeon, says "it was coiled with a single spiral of stout uncovered copper wire of 18 turns." I myself well remember seeing Sturgeon's apparatus in the Society of Arts Museum, and speaking from memory, the gauge was No. 16 B.W.G., the size at one time almost universally adopted for electrical purposes, no doubt because it was the size used for bell hanging, and therefore in the market.

Now, Dr. Silvanus Thompson says, "this coil was found appropriate to the particular battery which Mr. Sturgeon preferred. Surely this is special pleading. What Sturgeon attached so much importance to was the reduction of battery surface with the twofold view of lessening the inconvenience arising from battery fumes, and at the same time reducing the cost incidental to a large consumption of chemicals.

The battery employed by Mr. Sturgeon exposed only about one-ninth of the surface of the battery employed by Mr. Marsh, and had Mr. Sturgeon been acquainted with what is now known to even "half-educated electricians" of the present day, we may be very sure he would have increased the number of convolutions surrounding his soft iron core.

(*To be concluded.*)

ELECTRICAL STANDARDS COMMITTEE.

THE following resolutions are to be submitted to the next meeting of the Committee, to be held on Friday, the 20th February :—

1. That it is desirable that new denominations of Standards for the measurement of electricity should be made and approved by Her Majesty in Council, as Board of Trade Standards.

2. That the magnitudes of these Standards should be determined with reference to the centimetre as unit of length, the gramme as unit of mass, and the second as unit of time, and that by the terms centimetre and gramme are meant the standards of those denominations deposited with the Board of Trade.

3. That the Standard of Electrical Resistance should be denominated the ohm, and should have the value, 1000,000,000 in terms of the centimetre and second.

4. That the resistance offered to an unvarying electric current by a column of mercury of a constant cross-sectional area of one square millimetre, and of a length of 106·3 centimetres at the temperature of melting ice may be adopted as one ohm.

5. That the value of the standard of resistance constructed by a Committee of the British Association for the Advancement of Science in the years 1863 and 1864, and known as the British Association unit, may be taken as ·9866 of the ohm.

6. That a material standard constructed in solid metal, and verified by comparison with the British Association unit, should be adopted as the Board of Trade standard ohm.

7. That for the purpose of replacing the standard, if lost, destroyed or damaged, and for ordinary use, one or more copies should be constructed, which should be periodically compared with the standard ohm and with the British Association unit.

8. That the standard of electrical current should be denominated the ampère, and should have the value one-tenth (0·1) in terms of the centimetre, gramme and second.

9. That an unvarying current which, when passed through a solution of nitrate of silver and water containing from 15 to 20 parts by weight of nitrate of silver in 100 parts of water, deposits silver at the rate of 0·001118 of a gramme per second may be taken as a current of 1 ampère.

10. An alternating current of 1 ampère shall mean a current such that the square root of the time average of the square of its strength, at each instant, in ampères, is unity.

11. That an instrument contructed on the principle of the balance, in which by the proper disposition of the conductors

forces of attraction and repulsion are produced which depend upon the amount of current passing, and are balanced by a known weight, should be adopted as the Board of Trade standard for the measurement of 1 ampère, whether the current be unvarying or alternating.

12. That the standard of electrical pressure should be denominated the volt, being the pressure which, if steadily applied to a conductor whose resistance is 1 ohm, will produce a current of 1 ampère.

13. That the electrical pressure at a temperature of 62° F. between the poles or electrodes of the voltaic cell known as Clark's cell, constructed and used in accordance with the specification attached to these proceedings, may be taken as not differing by more than * parts in one thousand from a pressure of * volts.

REMARKS ON THE REPORTS CONCERNING EXPERIMENTS AT OERLIKON.

[FROM A CORRESPONDENT.]

THE experiments which have been proposed with reference to the projected utilisation of the water-power at Laufen on the Neckar for the Frankfort Exhibition by means of an electrical transmission actually took place on the day appointed, January 24th, and the reports in the daily press—rather meagre, certainly, from a technical point of view—are full of enthusiasm over the decided success of the experiments. The *Frankfurter Zeitung*, which was represented on this occasion by a special reporter, gives a very lengthy account of the proceedings, from which we learn that the tension of 30,000 volts was not obtained in the generator itself, but by means of a transformer which converted the 100-volt current of the generator into a current of high tension. This arrangement is certainly necessary for the Oerlikon machines with rotating induction coils. But in a rational and suitably constructed alternating current machine with fixed induction-coils, the production of a 30,000-volt current (with proper arrangements for insulation) would present no difficulties, and consequently the transformation in the production of the primary current would be unnecessary.

According to the reports in the daily press, the conduction over a distance of 7 kilometres was effected for the experiments by conveying the cable over 27 supports on 108 (?) insulators at distances of about 30 centimetres. As the experiments were intended to furnish a practical proof that the conduction of a current of 30,000 volts to very great distances presents no difficulties if proper arrangements are adopted, the question involuntarily occurs whether the experiments at Oerlikon, in which a cable-distance of 7 kilometres was artificially produced within a relatively very small distance, in fact, justifies valid inferences as to the phenomena which would occur on account of the varying atmospheric influences in grappling with a real distance of 180 kilometres.

The further communications of the reports which have appeared hitherto, extensive as they are, contain scarcely anything which could enable the technicist to form even an approximate opinion as to the value and the results of the Oerlikon experiments, Thus, *e.g.*, there is a report on the precautions taken against accidents to the conductors. But in this part of the report we find nothing save an account of the well known effects of the safety wires everywhere in use in transformers.

As an illustration of what must be thought of the reports in the daily Press concerning important phenomena in the technical sphere, I will quote the following passages from the report of the *Frankfurter Zeitung*:—

"In its conduction, and about in its middle, between two of the parallel wires, a connection was effected, but for the present it was not closed; only two pieces of wire were bent towards each other, and their ends were approximated more and more up to such a distance that an over-springing of the spark might be expected. When the machine was set in action the spark leapt over at the distance of 22 millimetres. This is much. It has been hitherto assumed that a few millimetres *suffice* (?) It is now demonstrated that a current of 22,000 volts does not spring over until the ends or the projections of the wire approach each other at the relatively great distance of 22 millimetres. The fabulous extreme danger of high-tension currents is reduced to nothing."

The only novel fact which we gather from the reports on the experiments at Oerlikon is that the transformers for the above-mentioned high-tensions are placed in oil insulators. I have learnt besides, through a private channel, that the starting of the motors for the intended transfer of power is proposed to be effected by means of steam engines, which are to serve to bring the motor up to the required number of rotations before it is inserted in the circuit of the current.

I must here not omit to mention that some time ago experiments were made by the firm "Helios," of Cologne, with alternating currents of a tension exceeding 20,000 volts, which yielded results concerning the striking distances of the sparks very different from those reported by the *Frankfurter Zeitung* at the Oerlikon experiments. I refer on this subject to the communications of Herr August Schneller in the *Elektrotechnische Zeitschrift* of November 7th, 1890, from which it appears that the spark strikes over 28 millimetres at 15,000 volts, and at 20,000 volts over about 64 millimetres.

Until we receive complete details concerning the electrical data, we must conclude from the very general reports of the political daily Press that nothing has happened at Oerlikon which supplies technically valid proof that the conduction of a current of 30,000 volts to a distance of 180 kilometres is permanently practicable with the appliances hitherto known. If this is still possible, means must be brought into play for this purpose, concerning which nothing is revealed in the reports which have appeared concerning the experiments at Oerlikon.

Nevertheless, electricians—and especially the representatives of the systems of transferring power to a distance—feel obliged to the daily Press for having taken such an interest in the Oerlikon experiments and excited such commotion in extended circles of readers, since thus the general public is familiarised with the thought that electric currents of very high tension may, and should be, made industrially serviceable. In this manner electro-technics, which have still to contend against a deeply-rooted distrust, will reap an important benefit. The Oerlikon Company merits gratitude as having given a salutary direction to public opinion by grandly-conceived and ably-executed experiments.

LONDON COUNTY COUNCIL.

AT the weekly meeting, held on Tuesday, the report of the Highways Committee was submitted.

Use of Subways by Companies and others.

We have proceeded upon the reference made to us on the 2nd of December, on the recommendation of the Improvements Committee, to consider and report upon the advisability of the council applying to Parliament for powers to compel gas, water and other companies to place their pipes, wires, &c., in the subway of Rosebery Avenue, and to enable the council to charge a rent for such user. We are advised that the council has at present no powers with reference to these matters, and that such powers cannot be obtained during the present session, as due notice has not been given of the intention to apply for them. It will be remembered that last session the Council's Subways and Overhead Wires Bill, as originally introduced, sought power to compel companies to place their pipes in subways already existing, as well as in subways to be constructed under the powers of the Bill; but that in consequence of the uncompromising opposition of the gas and water companies, that part of the Bill had to be abandoned. The Overhead Wires Bill of this session provides that where the council has a subway in any street any wires over the street which can be conveniently removed into the subway shall be so removed, and that the council shall charge a rent for the use of the subway; and in the Electric Lighting Orders provision is made for the laying of the mains in existing subways and for the payment of rent. We propose to consider in what way the objections of the gas and water companies to the laying in the subways of any new pipes which may be required may be met; and when the proper time arrives we hope to be able to advise the council whether, and if so in what way, the object of the reference may be effected. We may mention that, in our opinion, any application on the subject which may be made to Parliament should have relation to all the subways of the council, and should not be limited to that in Rosebery Avenue.

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* Blanks are left here in the report sent to us.—EDS. ELEC. REV.

Notices under Electric Lighting Orders and Acts.

We have considered a notice, dated 31st January, 1891 (Registered No. 156), from the Nottingham Electric Lighting Company, of intention to lay mains in Holland's Walk (1 plan). There is no objection to what is proposed, and we recommend that the sanction of the council be given to the works referred to in the notice (Registered No. 156), dated 31st January, 1891, from the Notting Hill Electric Lighting Company, upon condition that the company do give two days' notice to the council's chief engineer before commencing the work; that the cover stones of the culvert shall not be less than 2 inches thick, and that where the culvert crosses the carriage-way there shall be at least 9 inches' thickness of Portland cement concrete above the cover stones of the culvert in addition to the road material.

The Westminster Electric Supply Corporation has given a notice (Registered No. 157), dated February 2nd, 1891, of intention to lay mains in Denbigh Place (1 plan). The proposed works appear to be unobjectionable, and we recommend that the sanction of the council be given to the works referred to in the notice (Registered No. 157), dated February 2nd, 1891, of the Westminster Electric Supply Corporation, upon condition that the company do give two days' notice to the council's chief Engineer before commencing the work; that the mains be laid under the footways wherever it is found practicable to do so, and that the covers of the boxes to be used shall consist of iron frames filled in with material to suit the paving.

We have considered a letter from the Electricity Supply Corporation, asking that in the case of service lines from distributing mains the one month's notice specified in the St. Martin's Electric Lighting Order, 1889, may not be insisted upon, and that in place thereof the council will accept four days' notice. A similar application by the London Electric Supply Corporation was on our recommendation acceded to by the council on the 16th of December last; and we are of opinion that this also may be granted. We therefore recommend that the Electricity Supply Corporation be informed, with reference to the laying of service lines from distributing mains already laid, that the council will, until it gives notice to the contrary, accept four days' notice, instead of the one month's notice, required by the St. Martin's Electric Lighting Order, 1889; and that the Highways Committee be authorised to deal with such notices on behalf of the council.

LEGAL.

Dickens v. Metropolitan Electric Supply Company.—The application of Mr. Dickens for a new trial on appeal from the judgment of non-suit at trial before Mr. Justice Stephens with a special jury was heard on Wednesday last by the Master of the Rolls and Lords Justice Bowen and Fry. The case for the plaintiff was, that the defendant had cut off the electric light with which they were supplying him without giving due or reasonable notice. The electric light had been originally supplied by the Grosvenor Gallery, whose electric lighting business was subsequently taken over by Messrs. Pritchard & Co. A contract had been written out by the latter firm and sent to Mr. Dickens, who made two alterations in it, one fixing the time at which the light was to be turned on in the morning at 7 o'clock, and the other stipulating for a rebate of ¼d. per hour on each lamp whenever, through defective supply, gas had to be used. This contract had never been signed, but its terms had been confirmed in a conversation between Mr. Pritchard, jun., and Mr. Dickens. When the defendant company took over the supply another contract had been written out and forwarded to Mr. Dickens, the chief differences in which, as compared with the former, was that it slightly increased the price of the light, and that it was terminable by three months' notice instead of six, as the first had been. This contract had not been signed either, but it had been acted upon until such time as the defendant company had terminated the supply, without giving notice, thereby doing defendant considerable damage. Even if neither of the contracts were binding, it was argued that defendants were entitled to a reasonable notice. The price agreed on was an average one for winter and summer alike, and paid quarterly. The defendants had supplied the light during the summer months, but in November, when the plaintiff's busy season was coming on and the light was most required, they had cut it off. The learned judge had held, however, that the supply was only at will and could be terminated without notice by either party. They now applied for leave to begin a new trial. On the other side, it was contended that no binding contract had ever been made. The rebate made was not at the rate which Mr. Dickens had asked for, and the supposed contract between defendant and plaintiff was merely a circular that had been sent round to all the customers apprising them that the business had changed hands. There was no evidence at all from which a jury could conclude that a binding contract to supply electricity for a particular time had been made.

The MASTER OF THE ROLLS, in giving judgment, thought the learned judge had been too strict in regard to the signing of the contract. In his opinion, there was evidence of an agreement between Pritchard and plaintiff, one of the terms of which was that either party should be at liberty to put an end to the contract by six months' notice. There was evidence of the defendants continuing and plaintiff's receiving supply when the former took over the business of Messrs. Pritchard & Co. There was evidence of a letter by the defendants, in which they said that if plaintiffs did not agree to new terms now proposed, they would put an end to the contract which both asserted was then existing between them. He thought there was evidence to go to a jury, and that there must be a new trial.

Lords Justices BOWEN and FRY concurred.

Costs were granted to the appellants.

NOTES.

The Electric Light at Portsmouth.—The Electric Lighting Committee of the Portsmouth Town Council, as the result of a careful consideration of the matter in all its bearings, have resolved to recommend the municipal body to undertake the management of the electric lighting works to be established under the powers given by the Provisional Order, instead of leasing those powers to a private company. This decision was arrived at after the examination of returns showing the difference between the actual cost of supplying the districts mentioned in the provisional order obtained last year and the price which would be charged by a company. The difference was so large that the council will, the committee think, save a very large sum by carrying out the works themselves. The committee will propose the adoption of the low-tension system, by which the danger of overhead wires will be avoided, the wires being insulated by an ingeniously arranged covering and laid underground.

Western Counties and South Wales Telephone Company.—This company has made two important alterations in its regulations. One relates to the use of call-rooms. Hitherto call-rooms have only been available for use by subscribers within the district in which they resided; but now the subscribers to any of the Telephone Company's exchanges will have the right to use the call-rooms in all the towns in the district of the company, which includes all South Wales, Gloucester, Cheltenham, Bristol, so far east as Jersey and Southampton, Portsmouth and Bournemouth, and as far west as Exeter and Plymouth. No fewer than 55 towns are included in this district, and in most of them there are three and in some of them a dozen call-rooms. Another even greater convenience is about to be conferred upon the Telephone Exchange subscribers. For a year or more any subscriber has been able to be put through from his office or house to the post-office instrument-room, and thus send a telegram direct; but to obtain the right to this privilege it was necessary to pay an additional subscription of two guineas per annum. This subscription is now abolished, and any subscriber will be able to call up in Plymouth No. 199, viz., the post-office, and dictate a telegram, which will be immediately placed on the wires, the cost being debited to the subscriber's number, and an account sent in at the end of each month. The sole condition upon which this important facility will be available to all subscribers now is that they deposit with the post-office, through the telephone company, a sum equal to the value of the messages which they suppose they will transmit in the ensuing month.

Obituary.—*El Telegrafista Espanol*, of Madrid, announces the death, on the 3rd inst., of Excmo. Sr. D. Angel Mansi, who was Director-General of Posts and Telegraphs until the recent change of government in Spain. Those who attended the International Telegraph Congress which was held in Paris eight months ago will learn with regret that their sympathetic colleague has passed away.

The Practical Value of the Phonograph.—We are indebted to the New York *Electrical Engineer* for the following :—"The greatest feat of reporting that has ever been performed by the official reporters of Congress was that of preparing the Senate report for the *Record*, Wednesday night, January 14th. The chief reporter is sick, and but two men were available to do the work. The Senate was in session for fourteen hours, all of which time was spent in an entire discussion of the Silver Bill. It was after 12 o'clock at night when they adjourned, and during the session they had talked over 120,000 words. Two stenographers took the report, and, by dictating their notes into phonographs for typewriters to transcribe, they had all the copy ready for the printers by 8 o'clock in the morning, and the *Record* was on the desks of the senators when Congress convened."

Glasgow Electric Lighting.—Our advertisement columns give particulars of the invitation for tenders offered by the Glasgow Corporation.

Enriched Wire Casings.—Mr. F. A. Fawkes has published a book of new and special designs and photographs of architectural and enriched skirtings, dado rails, picture rails, cornices, &c., with grooves and portable covers for carrying electric wires. The enrichments, which are glued upon the covers, are made of a tough composition which, unlike plaster or cement, does not crumble, chip, or crack. The grooves are parabolic, a shape offering advantages for retaining the conductors when pressed into the grooves, and also allowing a certain amount of play for inequalities in the insulation. The book will be found useful by every architect and electrical engineer engaged in high-class work.

Elmore's Copper-Depositing Process.—The following letter was published in last week's *Engineering*:—"Your article of January 30th, on 'Elmore's Copper-Depositing Process,' giving some interesting details of manipulation, is the first printed description I have seen, and as the process is very interesting from a technical point of view, I should be glad to see the subject ventilated in your columns. From the description given in your article, it would seem that a loss of tension occurs in each bath of ·9 volt, and that the electromotive force of each tank is under 1 volt. If this is really so (which I doubt) it would mean that under 50 per cent. of the electric energy generated is utilised. It would be interesting to hear from your contributor if this is really so, and if so how this loss occurs, and how this loss compares with the loss of tension occurring in other installations for the electrolytic refining of copper. The Elmore process seems very suitable for the manufacture of large tubes where the cost of manufacture is a secondary consideration; but I fail altogether to see how it can hope to compete with the ordinary process of manufacture of solid-drawn copper tubes under 6 inches in diameter, or even under 9 inches in diameter; it is true that large solid-drawn tubes are expensive to buy, but this is partially owing to the small demand for large diameters. Presuming that the cost of depositing copper by this process 'from pole to pole' is at least as great as the cost of depositing copper electrolytically as carried on commercially at Birmingham, Hamburg, Oker, and many other places, I fail to see how it can compete with the ordinary process of manufacture from tough ingot; tough ingot is now worth, say, £55 10s., and electrolytic about £67 10s.; to this difference of £12 per ton must be added the royalty for the Elmore patent, say £3 per ton, together a difference of £15 a ton to start with, which is not a bad margin. Whether the small tubes drawn down from the skellets manufactured by the Elmore process are as good as those made in the ordinary method I am unable to judge, but I should fear a disturbance of structure on exposing the electrically-deposited skellet to the action of the draw bench. If, however, Messrs. Elmore have succeeded in obtaining, as I believe they claim, a deposit thoroughly homogeneous, my fears may be groundless. On the whole, the process seems to promise great things in the manufacture of large thick tubes, and if the question of getting a thoroughly homogeneous deposit is finally settled, I see no reason why we should not have electrically-deposited boiler flues, but I doubt if the process will ever be suitable for the manufacture of ordinary copper tubes under 6 inches internal diameter.—Yours faithfully, CUPRUM, *February 2nd*, 1891."

New Peru and Chile Cables.—The *Silvertown* has been reported from Arica, all well. She completed the cables between Chorillos, Iquique, and Valparaiso, on February 2nd.

Electric Traction and Liverpool United Tramways.—At the half-yearly meeting held on Saturday week, the Chairman, answering a question as to electrical haulage in substitution for horse-power, said that a trial had been made, and although the electric principle seemed to work exceedingly well, the car provided was too light for the steep gradients of Liverpool. Those interested in promoting electrical haulage had, however, undertaken to provide a stronger car, and it would have a fair trial. If then the system were found as economical as horse-power and the authorities permitted its use it would be adopted.

Benham and Froud, Limited.—These well-known lighting engineers have, with very good effect, introduced the new illuminant into their extensive show-rooms in Chandos Street, Charing Cross. Not only are the premises much better lighted than formerly, and the general stock seen to greater advantage, but the arrangement admits of a large range of pattern fittings being wired and switched on as required, so that customers can compare the appearance of the different combinations of holders and shades when lighted up. The current is obtained from the Sardinia Street Station of the Metropolitan Electric Supply Company.

The Dublin Corporation and Electric Lighting.—The meeting of the committee of the whole council, held on Friday week to consider the tenders for the public lighting of a portion of the city by electricity, was adjourned for the purpose of taking counsel's opinion as to whether a letter written by Mr. Bingham, manager of the House to House Electric Lighting Company, did not constitute a withdrawal of the tender sent in by that company. The opinion of counsel has not yet been obtained, and no date can yet be fixed when the committee will be again summoned to deal with the matter.

The Phenomena of Earth-Currents.—In a paper on this subject by Mr. W. Finn, read before the Buffalo Electrical Society, the author states a theory, which he says is the least unsatisfactory, to account for the existence of earth-currents. He says, "It is a well-known fact that a difference in temperature maintained at the opposite ends of a heterogenous conductor will cause a steady current of electricity to flow through it. Take, for example, a bar of copper and one of iron and solder them together at one end, leaving their opposite ends free, and connect these free extremities with a galvanometer. If, now, the point of junction between the two bars be heated, a current will circulate through the system, and its strength will be proportional to the difference in temperature between the soldered and free ends of the conductors. Now, the earth is a huge heterogenous conductor whose opposite sides are kept at unequal temperatures by the heat of the sun, and it is quite within the range of probability that thermoelectric currents are established and maintained in the earth the same as in a thermoelectric pile." Statements of this kind are often made in order to account for inexplicable phenomena, and go down as explanations; but where the explanation is we are puzzled to see. How the junction of two distinct masses of metal can be said to form a "heterogeneous conductor" we are unable to understand, and what similarity there is between a mass of mixed up materials such as we have on the globe, and two distinct masses of different material such as we have in an iron-copper bar is not evident. If we take a bar formed of a mass of iron and copper granules jumbled up together, and we heat any portion of the bar, we certainly do not get a current; and an experiment of this kind is certainly nearer what must actually take place in the case of the globe than the experiment mentioned by Mr. Finn.

Effects of a Storm.—The *Electrical World* of January 31st contains an interesting illustration, showing the damage caused to telegraph poles by a recent gale and snowstorm, resulting in the paralysis of the telegraph and telephone service of New York. Owing to the wires becoming mixed up with the electric light circuits, the working of the latter had to be suspended, causing great inconvenience. The fire-alarm systems also suffered, but fortunately no serious results followed.

Electric Traction in Berlin.—The chief magistrate of Berlin, in conjunction with all the members of the council, has decided that in future no concession will be given for the construction of high level electric railways, or for electric tramways, necessitating the use of overhead conductors carried on standards placed on the footpaths or carriage-ways. This decision is considered of great importance in Berlin, where electric tramway concessions have been asked for by at least two firms.

Barraclough and Company, Limited.—Messrs. T. Barraclough & Co., of Manchester, the well-known makers of wire-covering machinery, announce that they have opened offices at 20, Bucklersbury, London. Mr. Barraclough, who has had 25 years' experience in the designing and fitting up of industrial establishments, is prepared to advise intending purchasers of machinery, and to furnish estimates and plans for every kind of factory, including electric lighting plant and all requisites.

Electrical Railway for New York.—At a meeting of the Electrical Control, it was decided to give the electric railroad a chance, and the application of the Harlem Bridge, Morrisania and Fordham Railway Company for permission to erect a pole-line, and operate cars on the overhead electric system was granted.

Manganese.—Mr. G. G. Blackwell, of Liverpool, who claims to be the oldest importer of manganese, informs us that having put down new and improved plant, he is able better than ever to produce crushed and ground carbon as well as manganese, and to supply agglomerate blocks of exact constituency. Owing to the favourable position of his works, and the extent of his importations, he can offer special inducements to the consumer.

The Third International Exhibition of Machinery.—The Third Annual International Exhibition of Machinery, Manufactures, Appliances, and Inventions incidental to Engineers, Electricians, Builders, and Ironmongers, will be held at the Royal Agricultural Hall, Islington, N., from 23rd April to May 2nd next. It is proposed to render the forthcoming exhibition more interesting than was the case with the previous show last year, when, it will be remembered, electrical exhibits were for the first time admitted. There were not many exhibits of the latter class in 1890, but this year special attention is to be devoted to this branch. The distribution of free tickets to the various trades interested, which policy contributed largely to the success of the two previous shows, will be carried out more completely than before. Excursion trains will be run from all parts, and the promoters of the exhibition will forward admission tickets to electrical, mining, mechanical, and other engineers in the various towns from which the trains will run. The official catalogue will contain, in addition to description of exhibits, articles, statistics, &c., by well-known authorities, and of interest to engineers, electricians, builders, &c. Further information may be obtained on application to Mr. Harry Etherington or Mr. A. Blackman, at the offices, 43, New Oxford Street, W.

Jensen Bells.—The Jensen Electric Bell and Signal Company have favoured us with some advance sheets of a new catalogue of their manufactures which is about to be issued. The illustrations and prices are of interest to every-one in the trade.

Ship Lighting.—Messrs. Paterson and Cooper have secured the contract for lighting with 400 incandescent lamps the ss. *Furnessia*, of the Anchor line. This vessel is, we believe, that in which Barnum and his followers returned to the States.

Correction.—Mr. Gilbert's letter, published last week, on "Storms and Telegrams," should read, "The Government and certain railway companies," *not the Government of certain railway companies*, as printed; and Dalnaspidal, not Daluaspidel.

Society of Arts.—On Monday, February 16th, at 8 p.m., will be delivered the first Cantor lecture, on "The Electric Transmission of Power," by Gisbert Kapp, dealing with—Importance of transmission generally; distinction between live power and stored power; stored power transmitted by electricity and air under pressure; comparison between various ways of transmitting stored power; cost of transmitting by battery and electromotor; application to tram-cars.

Technical School and Electric Lighting at Preston.—The Preston Town Council has granted to the Harris trustees, a plot of 5,879 square yards of land for a technical school near the two railway stations most convenient for students from a distance. The building is to cost £10,000, and furnishing and endowment £20,000, the amount granted by the trustees. The Council also consented to the National Electric Supply Company applying for a provisional order to light the principal thoroughfares of Preston with electricity.

Woodhouse & Rawson United, Limited.—The following is a complete list of the Staff Lectures arranged for the winter and spring months.

Date.	Lecturer.	Subject.
Jan. 16.—	Mr. W. Stepney Rawson ...	"History of Electricity."
„ 23.—	Mr. Ludwig Epstein	"Secondary Batteries."
„ 30.—	Mr. F. H. Nalder	"Measuring Instruments."
Feb. 6.—	Mr. W. F. Bryan	"Dynamos and Motors."
„ 13.—	„ „	„ „
„ 20.—	Mr. W. Stepney Rawson ...	"Incandescent Lamps."
„ 27.—	Mr. Bertram Thomas	"Arc Lamps."
Mar. 6.—	Mr. Stuart A. Russell...	"Cables and Wires."
„ 13.—	Mr. Thomas E. Marsh	"Telephones."
„ 20.—	Mr. R. J. Jones	"Installations."
„ 27.—	Mr. Taylor ...	"Engines for Electric Lighting."
April 4.—	Mr. Nestle	"Boilers for Electric Lighting."
„ 11.—	Mr. W. S. Sargeant	"Electric Launches."

The lectures will be delivered in the Board Room, at No. 34, Cannon Street, E.C., at 6.30 p.m., each Friday, as above.

We regret that there is no paper on the electro-deposition of copper, but failing this interesting subject, the list is a fairly complete one, and the firm is to be congratulated on its enterprise in disseminating much useful knowledge amongst its *employés*.

New Denominations.—The *Daily Chronicle* of Wednesday, in informing its readers of the work of the Electrical Standards Committee, thus commences:—"The immense development of electrical science, especially in its practical relations, appears to have rendered it desirable that new denominations of standards for the measurement of electricity should be adopted. A system of measurement accordingly, approved by the Board of Trade, will be submitted for discussion at the next meeting of the Electrical Standards Committee, which will take place on the 20th inst." Then we are told that, should the committee approve of the resolutions, resistance, current and pressure will be measured in ohms, ampères and volts. The public ought to be grateful to the daily press of this country, for the *Chronicle* concludes that, by the adoption of these standards, the measurement of electrical power would be unified and systematised.

The Public and Electrical Supply Companies.—The application of Mr. Dickens for a new trial on appeal in the lawsuit brought by him against the Metropolitan Electric Supply Company has been unanimously granted by the three judges engaged in hearing the case. The matter is one of interest to supply companies and public alike, and particulars of the action may be seen in another part of this issue.

South Kensington and Paddington Subway.—In the face of the grave objections raised by the scientific teaching Institutions of South Kensington to this scheme, to which we have recently drawn attention, it is thought probable that the promoters of the subway will have the plans amended, so as to avoid coming too close to these establishments. We suggested in our issue of January 23rd that this was the only reasonable way out of the difficulty.

Mitis Metal for Dynamo Magnets.—With reference to this proposal, we find that the manufacture of the metal has been abandoned in this country, and that orders have to be supplied from a foundry in Belgium. For some purposes where machinery is not required on the castings, mitis metal is very suitable, but owing to the extreme difficulty of getting perfectly sound castings, they are not of much use where bright surfaces are required. We believe, however, that any reader who might feel disposed to give the metal a trial would be supplied by Messrs. Seebohm & Dieckstahl, of Sheffield. We also hear that Messrs. Hansell of the same town can supply it.

New Telegraph Facilities.—We quote the following from the *Financial Times*:—"Our Bradford correspondent telegraphs that owing to pressure of commercial telegrams from the North, the Government, in conjunction with the Commercial Cable Company, is about to open an office in Midland Buildings, Bradford. From this office a direct wire will run, *viâ* Liverpool, to Valentia, the station of the Commercial Cable Company. The office will be opened in a fortnight, and will be utilised as a Northern centre for cable communications direct to America. This will be great saving in time compared with the present practice, sending through London.

Competition Increases Business.—"During the past year the company has done a much larger general business than in any previous year, and a fair amount of cable work; but keen competition and increased cost of material continue to reduce the rate of profit." So runs a paragraph in the directors' report of the India-Rubber Gutta-Percha and Telegraph Works Company, Limited, and we imagine that the same thing applies to nearly all business houses. In these days of competition more business must be transacted than was formerly the case to keep up to the level of past years profits, and we wish all trading companies could show as good a balance-sheet as that of the company mentioned.

NEW COMPANIES REGISTERED.

The City of London Electric Lighting (Pioneer) Company, Limited.—Capital £100,000 in £50 shares. Objects:—To adopt agreements with the Brush Electrical Engineering Company, Limited, and The Laing, Wharton and Down Construction Syndicate, Limited, to take steps towards the formation of the larger company referred to in such agreements; to carry on in the City of London the business of an Electric Light Company; to carry on business as electricians, and to promote subsidiary companies, and for other purposes. Signatories (with one share each): Joseph Savory, Lord Mayor, Marlborough, Blenheim, Woodstock, Suffolk and Berkshire, Charlton, Malmesbury; Alan Chantres, 23, St. James's Place; J. B. Braithwaite, 27, Austin Friars, Stockbroker; J. C. Bull, Wilcote, Long Ditton Hill, Surbiton, Sec. W. A. Co.; Cecil Braithwaite, 27, Austin Friars, Stockbroker. The number of directors shall not be less than three nor more than five; qualification shall be the holding of shares of the nominal amount of £250; the first directors are so far exempted from this stipulation, that they may act before acquiring such qualification, but shall, in any case, acquire the same within one month from his appointment. Remuneration, £1,000 a year. Solicitors, Ashurst, Morris, Crisp & Co., 17, Throgmorotn Avenue, E.C.

CITY NOTES.

The Cuba Submarine Telegraph Company, Limited.

THE directors' report for the half year ending 31st December, 1890, presented at the thirty-ninth ordinary general meeting of shareholders on Wednesday, states that it will be seen that the gross receipts (including the balance brought from last account) amount to £21,325 19s., and the gross expenditure (including the half of the annual payment on account of the 1881 cable) to £6,759 11s. 3d., leaving a sum of £14,566 7s. 9d. to the credit of revenue account. Of this the sum of £4,450 13s. 10d. has been added to the reserve fund, which now stands at £79,000. The dividend on the preference shares will absorb £3,000, and leave £7,115 13s. 11d., out of which the directors recommend the payment of a dividend on the ordinary shares at the rate of 8 per cent. per annnm, free of income tax, the balance, £715 13s. 11d., being carried forward to the current half-year's account. The new cable between Batabano and Cienfuegos, referred to in paragraph 6 of the last report, was completely laid on 19th instant, but will not be taken over from the contractors until it has undergone the tests required by the contract. The instalments already paid have been deducted from the reserve fund, which will also be charged with the balance of the contract price. The Cienfuegos-Santiago 1881 cable broke down on the 21st August last, and the 1875 one, between the same points, became interrupted on 13th instant. The latter is now being repaired by the company's engineer, the vessel which laid the new Batabano cable having been hired for the purpose, and the restoration of communication is daily expected. When this is accomplished the vessel will proceed to repair the 1881 cable, the cost of which has to be borne by Messrs. Hooper, the contractors. A special meeting has been convened to remedy a defect in the articles of association, which is deemed to be necessary in the interests of the shareholders. With regard to the suit against the Spanish government, the necessary forms for bringing the case under the consideration of the Contencioso Court are not yet complete, but it is expected that within a short time the case will be ready for hearing.

The meeting was held as stated, Mr. Greenwood in the chair.

The CHAIRMAN said the incidents had been few during the past six months. As shown by the report there was an increase in the income; the expenditure had been increased, occasioned chiefly by a delay on the land lines. There had not been any breaks in their cable, a larger sum than usual had been carried to the reserve fund, and the usual dividend had been paid. He considered the affairs of the company were in a satisfactory state and pleasing to the shareholders. The action against the Spanish Government had been carefully considered by the Spanish lawyers and would shortly come before the courts, when they expected a decision in favour of the company.

In reply to a shareholder as to what was the cause of the action, the chairman said the Spanish Government had granted a concession to their rivals, the French company, giving them a right to lay a cable on the north side of the island, it was a direct violation of the concession made with the Cuba Company and hence the action.

After a further discussion the accounts were adopted.

At the close of the business an extraordinary meeting was held to alter the Articles of Association. This evolved an animated controversy on the part of one or two shareholders, but eventually the following propositions were carried into effect: "That the Articles of Association of the company be altered by the addition of the following article, and the same is hereby adopted as one of the regulations of the company: 'No person, not being a retiring director, shall be eligible for election to the office of director at any general meeting, unless he or some other member intending to propose him, has at least 14 clear days before the meeting, left at the offices of the company, a notice in writing under his hand, signifying his candidature for the office, or the intention of such member to propose him.'"

The India-rubber, Gutta-percha, and Telelegraph Works Company, Limited.

The directors' report for the year ending December 31st, 1890, to be presented at the 27th ordinary general meeting of the shareholders, to be held at the Cannon Street Hotel, London, on Thursday, 19th February, 1891, at twelve o'clock noon, states that the accounts show the net profit for the past year to be £65,334 11s. 2d. Adding £41,236 6s. 8d. brought forward, and deducting £20,800 interim dividend paid in July, there remains a disposable balance of £85,770 17s. 10d. The directors have added £25,000 of this balance to the reserve fund (raising it to £300,000), and recommend the distribution of a dividend of 10s. per share, free of income tax, amounting to £20,800, making, with the interim dividend, a total payment for the year of 10 per cent., and leaving £39,970 17s. 10d. to be carried forward. During the past year the Company has done a much larger general business than in any previous year, and a fair amount of cable work; but keen competition and increased cost of material continue to reduce the rate of profit. The works and machinery are maintained in a thoroughly efficient state. Mr. Bannatyne and Mr. Henderson, the directors retiring by rotation, offer themselves for re-election. Mr. Weise is re-eligible as auditor.

BALANCE SHEET, 31st December, 1890.

DR.—CAPITAL AND LIABILITIES.	£	s.	d.
Amount of authorised share capital	812,000	0	0
To share capital—Amount subscribed and paid on authorised issue of 41,600 shares of £10 each	416,000	0	0
" Mortgage debentures	200,000	0	0
" Reserve fund	300,000	0	0
" Steamers' maintenance fund	10,000	0	0
" Debts owing by the Company	63,752	9	3
" Unclaimed Dividends	2	10	0
" Proposed dividend, 5 per cent.	20,800	0	0
" Amount carried forward to 1891, as below ...	39,970	17	10
	£1,050,525	17	1

CR.—ASSETS AND EXPENDITURE.	£	s.	d.
By freehold land, buildings, and machinery at Silvertown and at Persan, and steamships *Silvertown*, *Dacia*, *International* and *Buccaneer*	478,952	5	9
" Freehold premises at Liverpool, and expenditure on Cannon Street premises	23,241	13	4
" Debts owing to the Company	89,222	14	4
" Cash with bankers and in hand	19,288	16	9
" Bills receivable	1,894	17	6
" Stock-in-trade, including cable on account of contracts	230,175	15	7
" Debentures and shares in other companies ...	33,890	10	0
" Cash, stock, &c., at Persan and other agencies ...	173,859	3	10
	£1,050,525	17	1

PROFIT AND LOSS ACCOUNT for the Year ending 31st December, 1890

DR.	£	s.	d.	£	s.	d.
To salaries, interest, rent, rates and taxes, repairs, and general expenses...				60,358	3	11
„ Bad debts				384	16	3
„ Income tax				1,589	0	0
„ Depreciation written of buildings and machinery				14,337	0	0
„ Addition to steamers' maintenance fund				5,000	0	0
„ Directors' remuneration (minimum)				2,000	0	0
„ Balance—profit for the year, carried down ...				67,971	14	8
				£151,640	14	10

	£	s.	d.	£	s.	d.
To Addition to reserve fund				25,000	0	0
„ Interim dividend of 5 per cent. paid in July	£20,800	0	0			
„ Proposed dividend of 5 per cent.	20,800	0	0			
				41,600	0	0
„ Balance to be carried to 1891				39,970	17	10
				£106,570	17	10

CR.	£	s.	d.	£	s.	d.
By gross profit, after charging commission, but including interest on debentures and shares in other companies				150,925	1	6
„ Income tax refunded				715	13	4
				£151,640	14	10

	£	s.	d.	£	s.	d.
By balance brought down ...	£67,971	14	8			
Less additional remuneration due to directors after payment of 10 per cent. to shareholders	2,637	3	6			
				65,334	11	2
„ Amount brought forward from 1889				41,236	6	8
				£106,570	17	10

I have examined the above accounts with the books and vouchers and the returns from the Persan and home agencies, together with the securities representing the investments held by the company, and certify to their correctness in accordance therewith.

The subsidiary books have, as usual, been examined in totals; and I have had produced to me the inventories of stocks on hand, certified by the Works Manager.

J. WEISE, *Auditor*.

London, *February 9th*, 1891.

Hastings Electric Light Company.

THE annual meeting of the Electric Light Company, Limited, was held last week at the works, Earl Street, Mr. H. M. Baker, J.P., Chairman of Directors, presiding. There were also present Messrs. J. Reeves, sen., F. Noakes (Battle), J. Woodhams, F. J. Parsons, and Councillor Roddis (directors), A. Bray, J. Reeves, jun., the Rev. J. W. Tottenham, and Messrs. F. E. Burton (secretary), Bragg, and Clark.

The following report was taken as read :—

The directors, in presenting the annexed accounts to the shareholders, for the nine months ending 31st December last, instead of the usual financial year, have to explain that the Board of Trade, under the provisions of the Electric Lighting Act, require the annual accounts to be made up to the 31st December in every year. It will be seen that the accounts are of a very satisfactory character, and that after paying all working expenses, and charging to revenue account all additions to plant, and also paying the interest on mortgage and debentures, there remains a net profit of £543 13s. 5d., including the balance of £97 0s. 11d. brought forward from the last account. The directors propose to pay out of this sum a dividend at the rate of 5 per cent. per annum, which will absorb £256 17s. 6d., leaving a balance of £286 15s. 11d., and they hope the shareholders will consider that the time has at last arrived when the services of the directors should receive some remuneration. The application to the Board of Trade for a Provisional Order under the new Electric Act has been successful; the advantages to the company will be many and great, but certain conditions have also to be complied with, and new machinery and alterations to existing plant will have to be made to fulfil such conditions, and to enable the company to extend its business. The sum of £2,000 will be sufficient for the present, and under the improved prospects of the company, the directors do not anticipate any difficulty in getting the 5 per cent. debentures taken up to this extent. Mr. Robert Hammond, who from the first has shown great confidence in the company, and is one of the largest shareholders, having agreed to take £500 of this amount. Messrs. Fredk. A. Langham, Fredk. Noakes, and Jas. Woodhams retire from the directorate by rotation; they are eligible, and offer themselves for re-election. The auditors, Messrs. Hart Brothers, Tibbets & Co., also retire, and offer themselves for re-election.

The CHAIRMAN announced that Mr. F. A. Langham, a director, was detained in London by business upon which he had been suddenly called away. He then moved the adoption of the report, which he considered the most important one since the formation of the company. Owing to the requirements of the Board of Trade, the balance-sheet was only for nine months' trading, which left out three of the best months of the year. Much of the success of the company was due to Mr. Mercer, the engineer, owing to the admirable way in which he looked after their interests. Referring to the request of the directors for some remuneration, he said they had attended 250 meetings since the company's formation. He referred at length to the Board of Trade order, observing that their present plant would serve, but they would have to get extra plant for incandescent lighting. He mentioned the handsome and praiseworthy manner in which Mr. Hammond, who was an extensive manufacturer of electric light plant, had come forward to help. The engineer of the Brush Company had told them that they had room to do five times the amount of business. They were in treaty to light the new St. Leonard's Pier, and two or three churches were only waiting for the plant to be laid down to be also supplied with the light.

Mr. J. REEVES, jun., seconded, and the motion was agreed to.

The retiring directors and auditors were re-elected.

Overhead Electric Railways.—The half-yearly meeting of the Liverpool Overhead Railway Company was held at Liverpool on Tuesday. Sir W. B. Forward (chairman) explained that the delay in construction had taken place mainly through the non-delivery of material. Progress now, however, was fairly rapid. The line, which is to be 5½ miles in length along the dock line, is complete for one mile from its northern extremity, and foundations have been laid to the centre of the city. It was hoped the northern section would be at work by October. Electricity was proposed as the motive power, and tenders from four engineering firms were to be in by the end of the present month. Quoting from American experience, the chairman showed the probable enormous growth of traffic on the line, and anticipated no difficulty in paying a good dividend. The report and accounts were adopted, and the chairman, replying to a vote of thanks, expressed the opinion that in not many years the overhead railway would be looked upon as the best railway property in Lancashire.

The City of London Electric Lighting (Pioneer) Company.—This company, taking over portions of the contracts of the Brush Company and Laing, Wharton and Down, has been formed with a capital of £100,000, in 2,000 shares of £50 each, its object being to initiate the supply of electricity for public and private lighting and for motive power and other purposes within the City of London, and with the intention of forming a larger company with adequate capital to acquire the undertakings mentioned, which will secure to such larger company the electric lighting of the whole of the City of London. The names of the directors appear in another column.

Edison and Swan United Electric Light Company.—The directors have decided to pay an interim dividend for the half-year ending 31st December, 1890, at the rate of 7 per cent. per annum upon the "A" shares, to be distributed in accordance with the articles of association.

Telegraph Construction and Maintenance Company's Dividends.—Subject to the audit of accounts, the directors propose paying a dividend of 15 per cent. (£1 16s. per share) in addition to the 5 per cent. already paid, making 20 per cent. for the year 1890.

The Westminster Electric Supply Corporation, Limited.—A final call of £1 per share has been made upon the shareholders.

TRAFFIC RECEIPTS.

The Brazilian Submarine Telegraph Company, Limited. The traffic receipts of the Brazilian Submarine Telegraph Company, Limited, for the week ended January 30th, 1891, amounted to £6,215; and for the week ended February 6th, £5,956.

The City and South London Railway Company. The traffic receipts for the week ended February 7th, amounted to £702.

The Cuba Submarine Telegraph Company, Limited. The estimated traffic receipts of the Cuba Submarine Telegraph Company, Limited, for the month of January, were £2,400, as compared with £3,176 in the corresponding month of last year. The decrease is owing to an interruption during the latter half of the month.

The Eastern Extension Telegraph Company, Limited.—The traffic receipts for the month af January amounted to £46,575, as against £40,610 in the corresponding period, showing an increase of £5,965.

The Eastern Telegraph Company, Limited. The traffic receipts for the month of January were £60,005, as against £59,478 for the same period of 1889, or an increase of £527.

The Great Northern Telegraph Company. Receipts in January, 1891, £20,800 corresponding month 1890, £19,600; corresponding month 1889, £22,400.

The Western and Brazilian Telegraph Company, Limited. The receipts for the week ending February 6th, 1891, after deducting 17 per cent. of the gross receipts payable to the London Platino-Brazilian Company, were £4,858.

The West Coast of America Telegraph Company, Limited. Traffic receipts for the month ending 31st January, 1891, £3,925.

SHARE LIST OF ELECTRICAL COMPANIES.

Present Amount Issued.	Name.	Stock or Share.	Closing Quotation. (February 5).	Closing Quotation. (Feb. 12).	Business done during week ending February 12, 1891.	
					Highest.	Lowest.
250,000*l*	African Direct Telegraph, Ltd., 4 p. c., Deb. Regd. and to Bearer	100	99 —102	99 —102	...	...
1,381,380*l*	Anglo-American Telegraph, Limited	Stock	48½— 49½	48 — 49 xd	49	48½
2,809,310*l*	Do. do. 6 p. c. Preferred	Stock	85½— 86½	84½— 85½	87	85½
2,809,310*l*	Do. do. Deferred	Stock	12½— 13	12¼— 12¾	12¼	12
130,000	Brazilian Submarine Telegraph, Limited	10	11¾— 12¼	11¾— 12¼	12$\frac{1}{16}$	11$\frac{15}{16}$
84,500*l*	Do. do. 5 p. c. Bonds	100	100 —103 xd	100 —103	...	...
75,000*l*	Do. do. 5 p. c., 2nd Series, repayable in June, 1906 ...	100	103 —107	103 —107	...	...
63,416	Brush Electric Engineering Ordinary, Nos. 1 to 63,416	3	2⅜— 2⅝	2⅜— 2⅝	2$\frac{11}{16}$	2$\frac{7}{16}$
63,416	Do. do. Non cum. Preference, Nos. 1 to 63,416	2	1½— 2	1½— 2	2	1$\frac{11}{16}$
$7,216,000	Commercial Cable, Capital Stock	$100	104 —106	104 —106	106	105
224,850	Consolidated Telephone Construction and Maintenance, Limited ...	14/-	$\frac{7}{16}$— $\frac{9}{16}$	$\frac{7}{16}$— $\frac{9}{16}$	...	...
20,000	Crompton & Co., Ltd, 7 p. c. Preference Shares, Nos. 1 to 20,000	Stock	5 — 5½	5 — 5½	...	...
16,000	Cuba Telegraph, Limited	10	11 — 12	10½— 11½	...	...
6,000	Do. do. 10 p. c. Preference	10	16½— 17½	16 — 17	...	...
12,931	Direct Spanish Telegraph, Limited, ... (£4 only paid)	5	3½— 4	3¾— 4¼	3⅞	...
6,000	Do. do. 10 p. c. Preference	5	9 — 10	9 — 10	...	...
60,710	Direct United States Cable, Limited, 1877	20	10⅛— 10⅜	10⅛— 10⅜	10⅜	10$\frac{5}{16}$
400,000	Eastern Telegraph, Limited, Nos. 1 to 400,000	10	14⅛— 14⅜	14⅛— 14⅜	14⅜	14⅛
70,000	Do. 6 p. c. Preference	10	15 — 15½	15 — 15½	15¼	...
200,000*l*	Do. 5 p. c. Debs. (1879 issue), repay. August, 1899	100	106 —109 xd	106 —109	...	...
1,200,000*l*	Do. 4 p. c. Mortgage Debenture Stock	Stock	106 —109	106 —109	108½	107½
250,000	Eastern Extension, Australasia and China Telegraph, Limited ...	10	14½— 15	14¾— 15¼	15	14$\frac{13}{16}$
320,000*l*	Do. 6 p. c. Debentures, repay February, 1891	100	... — ... xd	... ...	...	...
91,800*l*	Do. 5 p. c. (Aus. Gov. Sub.), Deb., 1900, red. ann. drgs. reg. 1 to 1,049, 3,976 to 4,326	100	102 —105	102 —105	105	...
325,200*l*	Do. do. Bearer Nos. 1050—3,975 and 4,327—6,400 ...	100	102 —105	102 —105	105	...
145,300*l*	Eastern and South African Telegraph, Ltd., 5 p. c. Mort. Deb. 1900 redeem. ann. drawings, Registered Nos. 1 to 2,343	100	102 —105	102 —105	...	...
198,200*l*	Do. do. do. to bearer, Nos. 2,344 to 5,500	...	102 —105	102 —105	...	...
201,600*l*	Do. do. 4 p. c. Mort. Debs. Nos. 1 to 2016, red. 1909	100	99 —101 xd	99 —101	...	...
45,000	Electric Construction, Limited, Nos. 101 to 45,100	10	6½— 7	5½— 6½	...	...
19,900	*Electricity Supply Co. of Spain, Nos. 101 to 20,000	5	4½— 5	4½— 5	...	...
70,000	Elmore's Patent Copper Depositing, Limited., Nos. 1 to 70,000 ...	2	3¾— 4¼	3¾— 4¼	4⅛	3⅞
67,385	Elmore's Wire Mfg., Ltd., Nos. 1 to 67,385, issued at 1 p.m., all pd.	2	1¾— 2¼	1½— 2	1$\frac{11}{16}$	...
20,000	Fowler-Waring Cables, Nos. 301 to 20,300 ... (£4 only paid)	5	2½— 3½	2½— 3½	...	...
180,227	Globe Telegraph and Trust, Limited	10	9 — 9¼xd	9 — 9¼xd	9¼	9$\frac{1}{16}$
180,042	Do. do. 6 p. c. Preference	10	14⅞— 15⅛xd	14⅞— 15⅛	15$\frac{1}{16}$	14⅞
150,000	Great Northern Tel. Company of Copenhagen	10	16¾— 17¼	16¾— 17¼	16$\frac{15}{16}$	16$\frac{11}{16}$
230,000*l*	Do. do. 5 p. c. Debs. (issue of 1883) ...	100	105—108	105 —108	106½	105½
9,384*l*	Greenwood and Batley, Ltd., Ordinary, Nos. 4667 to 14,000 ...	10	10½— 11½	10½— 11½	...	...
5,334*l*	Do. 7 p. c. Cumulative Preference, Nos. 2,667 to 8,000	10	11 — 12	11 — 12	...	...
41,800	India-Rubber, Gutta Percha and Telegraph Works, Limited ...	10	18½— 19½	19 — 20	19½	...
200,000*l*	Do. do. 4½ p. c., Deb., 1896	100	103 —105	103 —105	...	...
17,000	Indo-European Telegraph, Limited	25	35 — 37	36 — 38	...	...
11,334	International Okonite, Ltd., Ordinary Nos. 22,667 to 34,000	10	9¼— 9¾	9¼— 9¾	...	...
11,334	Do. do. Preference Nos. 5,667 to 17,000 ...	10	9¼— 9¾	9¼— 9¾	...	...
38,348	London Platino-Brazilian Telegraph, Limited	10	6 — 7	6½— 7½	...	...
100,000*l*	Do. do. do. 6 p. c. Debentures	100	108 —111	108 —111	...	...
43,900	*Metropolitan Electric Supply, Ltd., Nos. 6,101 to 50,000 (£8 paid)	10	7½— 8	7¾— 8¼	8	7½
438,984	National Telephone, Limited, Nos. 1. to 438,984	5	4⅝— 4⅞	4⅝— 4⅞	4⅞	4$\frac{11}{16}$
15,000	Do. 6 p. c. Cum., 1st Preference	10	12½— 13	12½— 13	12¾	...
15,000	Do. 6. p. c. Cum. 2nd Preference (£8 only paid)	10	10 — 10½	10 — 10½	...	...
220,000	Oriental Telephone, Ltd., Nos. 80,001 to 300,000 (11s. only paid)	1	$\frac{3}{16}$— $\frac{5}{16}$	$\frac{3}{16}$— $\frac{5}{16}$	$\frac{5}{16}$	¼
9,000	Reuter's Limited	8	8½— 9	8½— 9	8¾	8⅝
209,750	South of England Telephone, Limited, Ordinary Nos. 1 to 2,000, 2,501 to 3,500, 93,251 to 300,000	1	⅛— ⅜	⅛— ⅜	...	...
20,000	Do. 6 p. c. Cum. Pref., Nos. 1 to 20,000 (£3½ only paid)	5	2¾— 3¼	2¾— 3¼	...	...
3,381	Submarine Cables Trust	Cert.	112 —115	112 —115	115¾	...
78,949	Swan United Electric Light, Limited ... ... (£3½ only paid)	5	4½— 5	4½— 5	4⅞	4¾
37,350	Telegraph Construction and Maintenance, Limited	12	47 — 49	47 — 49	48¼	47½
150,000*l*	Do. do. do. 5 p. c. Bonds, red. 1894	100	102 —105	102 —105	...	...
58,000	United River Plate Telephone, Limited	5	3 — 4	3 — 4	...	...
146,128*l*	Do. do. 5 p. c. Debenture Stock ...	Stock	90 — 95	90 — 95	...	...
3,200*l*	Do. do. 7 p. c. Debs., Nos. 1 to 1,000 ...	100	... ...	... ...	...	...
15,609	West African Telegraph, Limited, Nos. 7,501 to 23,109	10	8 — 9	8 — 9	...	...
290,900*l*	Do. do. do. 5 p. c. Debentures	100	98 —101	99—102	101½	100¾
30,000	West Coast of America Telegraph, Limited	10	2 — 4	2 — 4	...	...
150,000*l*	Do. do. do. 8 p. c. Debs., repayable 1902 ...	100	95 —100	95 —100	...	...
64,174	Western and Brazilian Telegraph, Limited	15	11¾— 12¼	12¼— 12¾	12¾	12¼
27,873	Do. do. do. 5 p. c. Cum. Preferred	7½	6½— 7	6¾— 7¼	7	6⅞
27,873	Do. do. do. 5 p. c. Deferred	7½	5¼— 5¾	5½— 6	5⅞	5½
200,000*l*	Do. do. do. 6 p. c. Debentures "A," 1910 ...	100	102 —105 xd	103 —106	...	...
250,000*l*	Do. 6 p. c. Mort. Debs., series "B" of '80, red. Feb., 1910	100	102 —105 xd	103 —106	...	...
88,321	West India and Panama Telegraph, Limited	10	2¾— 3	3⅛— 3⅜	3$\frac{7}{16}$	3$\frac{1}{16}$
34,563	Do. do. do. 6 p. c. 1st Preference ...	10	11¼— 11¾	11¼— 11¾	11⅝	11⅜
4,669	Do. do. do. 6 p. c. 2nd Preference ...	10	11 — 12	11 — 12	11$\frac{11}{16}$	...
$1,336,000	Western Union of U.S. Tel., 7 p. c. 1st Mortgage (Building) Bonds	$1,000	120 —125	120 —125	...	...
175,100*l*	Do. do. 6 p. c. Sterling Bonds	100	99 —103	99 —103	...	...
42,853	*Westminster Electric Supply Corporation, Ord., Nos. 101 to 42,953	3	3½— 4	3¾— 4¼	4	3⅞

* Subject to Founders' Shares.

LATEST PROCURABLE QUOTATIONS OF SECURITIES NOT OFFICIALLY QUOTED.

Blackpool Electric Tramway Company, Limited, £10 (£6½ paid), 7⅛—7⅜.—Elmore Copper Depositing Priorities, 7—7½.—Elmore's French Patent Copper Depositing shares of £2 (issued at 10s. premium, £1 10s. paid, including premium), 2½—2⅝.—House to House Company (£5 paid), 4¾—5¼.—London Electric Supply Corporation, Ordinary (£5 paid), 1¼—1¾.—Manchester Edison and Swan Company, £9 (£1 paid) 11s.—13s.—St. James's and Pall Mall Electric Light £5, 5¾—6¼.—Woodhouse & Rawson Ordinary of £5 (£2 10s. paid), 2⅜—2½.—Preference, 4⅜—4⅝.

BANK RATE OF DISCOUNT.—3 per cent. (29th January, 1891).

COMMERCIAL RATING OF ELECTRIC GENERATORS.*

By THOMAS G GRIER.

GOOD engineering requires that specifications should have their aims, objects, and purposes defined with accuracy. The generator of an electric light or power plant is one of its most essential features, and in defining or in rating its capacity we should do so in terms that have a tangible meaning.

The standard electrical units by which electric light installations may be specified are the ohm, volt, ampère and candle-power, and in electrical power installations substituting the horse-power for the candle-power.

Instruments for measuring the ohm, volt, and ampère have been adapted to the necessities of practical engineering, and when these three units are the basis of a specification it is with comparative ease that an expert can ascertain the correctness of the work.

In the majority of specifications and contracts, as now drawn, the capacity of the wiring will be for so many 16 candle-power lamps, or for so many horse-power motors; and the generators will be rated in so many 16 candle-power lamp capacity, or for so many horse-power motors.

This use of the units, candle-power, and horse-power, virtually means nothing.

The arc lamp of so many nominal candle-power is another unit which means nothing when applied to the capacity of the machine.

The candle power unit is in a measure open for criticism on the point of accuracy, but in the discussion the discrepancies that may exist in the several standards are not the points to be considered. The candle-power unit is a unit of light. Our generators do not produce light, but electrical energy. Our arc and incandescent lamps convert the electrical energy into heat and light. The horse-power is the unit of power. Our generators do not produce the power, but our motors utilise the electrical energy and convert it.

Before considering why we should not use the terms candle-power and horse-power in rating our generators, even though these terms are perfectly correct, we will discuss the converting apparatus, that is, the incandescent lamp, the arc lamp and the motor.

The incandescent lamp being an apparatus for converting electrical energy into light with an unfortunate side product of heat, does not give back 100 per cent. of the electrical energy as light, nor does the proportion that produces light and the proportion that develops heat vary in the same ratio under different conditions. Lamps are in use to-day that vary in the consumption of energy per candle-power produced from 3 to 7 watts, and even as low as 2 watts has been claimed. This variation in the energy, when the lamps are of the same voltage, means a variation in the amount of current necessary to produce the equal amount of light. Recent experiments made upon lamps bought in the open market show conclusively that lamps of the same rated voltage and candle-power are not uniform. Here are a few instances of the variations of the amount of current required.

First, 20 lamps, 10 each of two different makes, were placed upon ordinary commercial meters, and were burned for the same length of time. To eliminate the errors of the meters they were transposed so that each set burned an equal time on each meter. The result of the experiment showed that there was a difference of 27 per cent., in the amount of current consumed, between the sets.

2. Another station tried the same experiment, using one set of lamps of a different make from that of the former, and one set of the same make. The result of their experiment was a difference of 22 per cent.

3. A station operating some 700 lights had a number of the nominal 16 candle-power lamps that were in use tested, and found the candle-power to range from 17 to 22 candle-power. On discovering this, nominal 10 candle-power lamps were used and called 16 candle-power. As the current was sold by meter, the customer was in no way injured by the substitution.

4. A number of large lamps were tested, and nominal 100 candle-power lamps were found to give from 44 candle-power up to 110 candle-power.

5. In December, 1890, tests were made on four different makes of lamps. All the lamps were marked by the manufacturers at the same voltage, and all were nominal 16 candle-power lamps. The tests showed a variety of candle-powers ranging from 11 up to 24, and efficiencies from 2·46 watts to 4 watts per candle-power.

6. A large lamp of new make of nominal 150 candle-power gave an efficiency of 2·4 watts per candle-power. As this was the most efficient of any lamp tested it has been placed on the circuit of a central station, and is undergoing a life test.

These experiments are of considerable value in this paper as proofs of the desired end in view, as they show that when capacity is given in candle-power it means only an approximation. We, however, should not draw conclusions as to the real commercial value of the lamps tested.

The durability of a lamp is a most important factor, and without a test as to the life of the various lamps and a mathematical equation being deduced that would include life, efficiency, and cost of lamp, no actual commercial conclusion should be drawn. It is a well known fact that the life of a lamp is dependent upon the efficiency at which it is used. A lamp can be made to produce light commercially at an expenditure of energy varying from 2 to 7 watts per candle-power.

The factors that govern the efficiency at which the lamp should be run are, the cost of producing the electrical energy, and the cost of the lamps.

From this view of the matter, even though the lamps were uniform, it is possible to have conditions wherein would exist a difference of over 100 per cent. in the amount of current necessary to produce equal amounts of light.

When a specification requires that an incandescent dynamo should have a capacity of 100 16-candle-power lamps at 110 volts, what does it mean? Must the machine be capable of producing energy sufficient to operate lamps at 7 watts, or but 2 watts per candle-power.

Must it develop 30 ampères, or about 102 ampères? Either machine being within the range of the specification, the efficiency of the lamps entirely governing the size. If nothing further than the capacity in candle-power is specified what right would the purchaser have to grievance or redress if the machine of the smallest limit (that is 30 ampères) were sold to him as a 100-light machine, his lamps requiring more ampères than 30?

The arc lamp is also an apparatus which converts our electrical energy into light and heat. Its efficiency when well adjusted and carefully cared for, should not vary to any great extent. Bad adjustment is a baneful cause of poor efficiency, and good adjustment cannot be maintained without good regulation. To measure the candle-power of an arc lamp is not the easiest matter in the world, and for one to attempt to judge by the eye is an absurdity.

In tests that have been made on arc lamps, the results were from $\frac{7}{10}$ths of a horse-power up to 1 $\frac{4}{10}$ths horse-power per lamp of 2,000 candle-power, so-called. These figures were based upon the difference between the total horse-power exerted by the engine, and the horse-power of the engine running empty and the belt thrown off the dynamo.

As the actual candle-power of the lamp could not be measured it remains still a matter of conjecture whether the machines were really of so many 2,000 candle-power lamp capacity.

The motor is another apparatus for transforming electrical energy into different forms. The efficiencies of the various motors on the market vary from 90 odd per cent. to as low as 50 per cent., and perhaps lower. Their efficiency also varies with their speed and load.

The generator for a 10 horse-power motor could mean a machine capable of generating anywhere from 11 horse-power up to 20, depending entirely upon the economy with which the electric motor would utilise the energy supplied by the generator.

The question of rating the machines in the units which measure the work of another piece of apparatus is merely rating the machine upon a variable standard, that is, the efficiency of another machine. We do not rate our engines in the capacity of the dynamo, but upon a unit of its own—the horse-power, giving the speed and pressure at which this horse-power is developed.

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* Read before the Chicago Electric Club, January 19th, 1891.

The boilers, however, are frequently rated in the unit horse-power, which unfortunately is as great a mistake as the rating of dynamos or generators in any other unit than that of the form of energy which is directly produced by them.

The transformation, or the conversion, of any form of energy to another must take into consideration the efficiency of the converting apparatus.

In transmitting energy from the point of production to the point of consumption, a loss is entailed. To convey electrical energy for light and power we use a metal conductor. The size of this conductor is not dependent upon the amount of horse-power developed or the amount of candle-power developed, but upon the amount of current transmitted, and the amount of pressure behind it. It is within the limits of possibilities wherein the current to develop the same amount of light or power may be double in one case what it would in another, owing to the difference in efficiency of the converting apparatus.

Another point to consider besides the efficiency is the resistance in the conductors. In some cases where fuel is extremely cheap, a large percentage of the energy may be used in transmitting the power, and consequently the generator would have to have an increase added to its capacity in proportion to this percentage that is lost. Tables for the use of wiremen have been prepared by the various companies, and while speaking of the generator it is just as well that attention should be called to the tables. Units used as a basis for their determination are the horse-power and the 16 candle-power lamp. It is apparent that a wire to carry a 16 candle-power lamp or a horse-power with a certain per cent. loss, does not even mean an approximation, the variable conditions that exist giving the expression only a very general meaning. The lamps or horse-power are assumed to take a certain amount of current, and, though the calculations are correct, the entire table depends for its accuracy upon how near the assumption approaches the actual efficiency of the apparatus used.

The capacity of the generators should be specified in the units that measure the energy in the form in which it is developed. Dynamo-electric machines develop or produce electrical energy measured in volts and ampères. The carrying capacity of wires for the transmission of this energy depends upon volts and ampères. The candle-power and horse-power have naught to do with it. Electrical generators should have their capacity specified in volts and ampères or in watts giving the pressure in volts at which this specified power is produced. The size of the wires should be determined upon the basis of ampères and volts, stating the percentage or number of volts lost in transmitting the current.

The English manufacturers give the capacity of the dynamo in watts, and a purchaser, even if he be ignorant of the first principles of electric machinery, could with little trouble find whether he had received the capacity that he had paid for. But had the rating been in candle-power or horse-power the result could not have been so satisfactory.

The Edison Company in the United States and several others of the larger electric manufacturing companies have given the capacity of their various generators in watts, but the agents and contractors seem invariably to overlook this, and propositions and contracts are drawn up with the generators rated in the indefinite terms, horse-power and lamps or candle-power.

Why the Americans have adopted the candle-power and the horse-power as a basis of rating electrical machinery and the compiling of wiring tables, is, perhaps, apparent to many; and the reasons were, no doubt, at one time good. It is, however, obvious that this general use of these technical terms is entirely wrong, and the electrician must be the means of reorganising the system. The tendencies are in the direction of this needed reformation, but the change cannot be too rapid nor too soon.

The fundamental principles of Ohm's law are thoroughly familiar to the intelligent workmen, and the sooner our calculations are confined to its mathematical accuracy, and our generating machinery rated in the proper units, the better for the electrical business.

AMERICAN INSTITUTE OF ELECTRICAL ENGINEERS.

AT the fifty-third meeting of the Institute, held on January 20th, the evening was devoted to the thorough discussion of Mr. Kennelly's paper on "Inductance and its Proposed Unit, the 'Henry,'" and the report of the committee appointed to consider the proper magnitude of the unit. The report of the committee was finally adopted, and is as follows:—

"At a meeting of the American Institute of Electrical Engineers, held September 16th, 1890, a committee consisting of Dr. Wm. E. Geyer, Dr. Louis Bell, George M. Phelps, Edward A. Colby, and Francis B. Crocker, chairman, was appointed to consider and report upon the best value for the 'Henry'—the proposed practical unit of self-induction or inductance.

"After careful consideration the committee has reached a conclusion and now recommends to the Institute the retention of the present value of the practical unit, which is 10^9 absolute units of inductance, usually expressed as a length equal to one earth's quadrant or 1,000,000,000 centimetres.

"The committee finds that this value is too high in some cases for convenience, as many practical measurements of inductance would have to be expressed in fractions of a Henry. At the same time other practical values would often amount to a number of Henrys, and sometimes to hundreds and even thousands of Henrys. It is, of course, impossible to have a unit fit all cases, and in this instance it happens that the average practical inductance would approximate one Henry in value. This may be considered fortunate. Small values may be conveniently expressed in millihenrys, analogous to milliampères, &c.

"The committee is of the opinion that even if the value of this unit (10^9 absolute units) had been much less convenient than it is, nevertheless it would probably be very unwise to change it, for the reason that it is derived from and related to the other practical units in the ratio of one to one, just as one ampère is equal to one volt divided by one ohm. To depart from this plan, which has always been followed heretofore, would tend to destroy the harmony of the entire system of practical electrical units. The same fact made it necessary to define the farad as a capacity of one coulomb at one volt, although this makes its value so enormous that the microfarad is always used in practical work. It appears, therefore, to the committee that the value of the 'Henry' should be fixed at 10^9 absolute units of inductance."

THE LONG CREDIT SYSTEM.

[COMMUNICATED.]

AT the back of many a liquor bar out West, standing out in relief to the rows of bottles and glasses on the shelves, may be seen, if not a thing of beauty, at least the only one there that could claim any kindred with art, the illustration of a prone hound under which is inscribed the touching words, "Poor Trust is Dead: Bad Pay Killed Him."

Although the designer be lost to fame, yet are his words words of wisdom, and oft has his homely sketch 'monished the thriftless one that for him could be no more chalkings up behind the door, and taught him the lesson that if he would have goods there he must pay for them, and if he could not pay he must go without.

It would not be amiss for the electrical trade if some of its clever members could devise such a simple means of appealing to the consciences of its customers and to its own. "Monthly account" may be read in many quotations, and is theoretically the custom of the trade; but there is more breach of this custom than observance. One cannot help thinking that it would be very much better for the industry if the go-as-you-please system, or want of system, were now made to give way to stricter rules.

Electrical business has been subjected to such rapid expansion, that what has been sufficient capital one year has been inadequate the next, and with extra money locked up in plant and book debts it has been hard work to keep up regular payments. Much of the supply has been taken by the rich, men who have their half-yearly audits or Christmas bills, and are apt to think every one has money because they have, and should give as long credit as their tailor. It may be difficult to teach such that they do not pay so much for profit in their electric light account as they do on their clothes. I hope much more lighting may be done for them, but they ought to be made to pay proportionately to the length of time they take before settling. It is hard on prompt payers to bear the sins of the long-credit customers.

In some of the larger companies so much has had to go to the lawyer, the expert, and the patent agent, that the manufacturer has often had to wait; dole being given only to the most hungry and persistent—the sturdy beggars who would not be denied—pending the raising of fresh capital. It is pleasing to say the state of the companies in this respect is much better than it was, but they have not always set a very good example. Dwindling business, as well as increasing, has been one cause of bad pay in some quarters; but, on the whole, the failures have not been so very many in proportion to the number of firms engaged; quite enough, however, to teach caution, and the lesson that every day a debt gets older it becomes less easy to collect, and may go fast and faster to the bad.

"Finance is the art of using other people's money," and some firms have doubtless used more of other people's than of their own, and and thought it clever to do so. We all laugh with the man, who deeply in debt, when asked by his friends "How can you sleep?" replied, "Oh! I can sleep all right; but I often wonder how my creditors can." We laugh, but we do not like him. The cold-blooded selfishness of keeping people without their money just because it suits you, and not because it is a case of dire necessity, is apparent to most.

"Money answereth all things"—collectors especially. It also saves unpleasant questions, such as, "When shall I call again?" "Well! when *will* you have a board meeting?" "Is the secretary likely to be ill long?" "Hasn't the cashier come back from his holiday yet?" "If your Mr. William is not in just now, when do you think he *will* be in?" &c. Its possession makes respectability. Was not he held respectable whose father kept a gig? *Dives equûm, dives pictae vestis et auri*, the nag, the rug, and the gold implied by their possession.

There are a few firms of whom we hear it said, "The most respectable people in the trade: first-rate pay." It would be a good thing if the same could be said of all, which the remark itself shows that it cannot be.

The electrical business is a growing one, and comparatively safe. Numbers are living by it already, and yet more can find in it occupation and profit. At a time when so much money is on deposit at banks at next to no interest, waiting sound investment, and suspicious of the channels offering, it is remarkable that young firms of good character should not have more offers of support than needful, and that there should be no rush for well-devised lighting companies. There was a time when young men of integrity found no difficulty in borrowing money to commence and carry on business, but that was before the days of monster joint stock companies and large foreign loans at high interest. People with spare means seem nowadays more ready to risk their money in speculative stocks, or buy the better class ones at a high figure, than to look out for the employment of their wealth in rising genuine business. It is easier to go to a broker, take his advice and sign a transfer, than to investigate such matters, it is true; but in the end the trouble taken would be justified. The risk would not be greater, and the profit probably more. It is a consummation devoutly to be wished, were it only that payments might be made more regularly. Strict payment would doubtless weed out some weak ones, but this would not be an unmixed evil. It would make people look ahead, and generally keep them up to the mark, if it were understood that pay days must be observed solemnly. It would be better for them individually and generally.

Too often is heard the plea: "My customer has not paid me yet; when he does, I will pay you." This, although it may certainly be a reason for a deficiency in the wherewithal, is an excuse which does not excuse from the obligation to meet an account when due. Prices are based on various considerations, and one of them is interest on outlay and allowance for proportion of possible bad debts. Prompt payment all round would mean larger turnover for the capital employed and safer business, resulting in cheaper work and goods. The cheaper, the wider will be the range of business to be done and the more business the better for the trade. The third-class passenger is not an unremunerative customer of the railways, and the sooner electric light, traction as well as domestic and other power—perhaps even heating—become within the reach of the many, the better will it be for everyone connected with electricity.

Small profits and quick returns should be the order of the day. The profits are, I think, not often exorbitant. "Catch a flat," may be good advice, but they don't rise to every cast, they are not always on the feed, want a lot of play, and by their very nature are apt to struggle at the last minute and not get landed. The bulk of business done is at fair rates, and some cut too fine; but money does not always come in as quickly as it should. The best way is to make definite arrangements first. "Leave it to you, Sir," may pay the cabby, but not the electrical engineer or manufacturer. It is always a delicate matter to say to a man, "I wont supply you." Competition is so rife that his reply would be, "All right, don't, I'll go to someone else." It is probably best, however, under such circumstances, to let someone else have the chance of the profit or bad debt.

I have gone into this subject at some length because I thought it could do no harm and might perhaps do some good, and this must be my apology to any of my readers who may feel inclined to charge me, as regards the length of this article, with longwindedness.

ABSTRACTS OF PUBLISHED SPECIFICATIONS, 1889.

17,425. "Improvements in electric arc lamps." H. Harper. Dated Nov. 2. 8d. Consists, first, in improved means for regulating the feed of the carbons, secondly, in an improved method of constructing the solenoid-core whereby it is rendered specially adapted for use with alternating currents, and, thirdly, to certain devices for enabling the carbons to be readily fixed and accurately centred and otherwise for ensuring efficiency in the working of the lamp. 5 claims.

20,244. "Improvements in electric-generating machinery for use in connection with the electric lighting of railway trains." J. H. Holmes. Dated Dec. 17. 11d. The inventor constructs a dynamo electric machine with two armatures arranged to revolve together but in separate magnetic fields. The one is the main generating armature, the other being for regulating the strength of the magnetic field of the generating armature. He separately excites the magnets of the machine from some external source such as a set of accumulators and provides the magnets ot the generating armature with two distinct exciting circuits. One circuit is a high resistance shunt circuit, and the other is of less resistance and is coupled up to the source of current so as to have the small regulating armature in series with it. The regulating armature is so coupled up that its own E.M.F. opposes the E.M.F. of the source of supply. 6 claims.

20,955. "Improvements in dynano-electric machines, in part applicable to electro-motors." J. J. Wood. Dated December 31st. 1s. 5d. Consists in part of improvements in automatic regulators for governing dynamo machines, in order that they shall generate uniform currents under all circumstances. Another part of the invention consists of improvements in the armatures of dynamos, the improvements pertaining chiefly to the armature core and to the supporting spider. 17 claims.

20,991. "Improvements in electric and magneto bells and apparatus to be used therewith." H. P. F. Jensen and J. Jensen. Dated December 31st. 8d. The inventors form the armature of bells or indicators of a thin piece of iron or steel or both suitably united, the upper end being made quite thin to form a spring and bent at right angles and having an eye for passing the core shank through it and through the top of the bell, one nut at the end of the shank serving to hold the armature, the break spring, the insulating disc, the core and the bell together. The bottom end of core is cut off square or sloping, and the lower end of the armature and of the break spring are bent and continued down below it, thus rendering access to the break spring easier than heretofore. 10 claims.

1890.

1,347. "An improved fluid for primary batteries." T. Coad. Dated January 25th. 4d. In 10 ounces of nitric acid is dissolved 4 ounces of mercury, then add 1 ounce of carbonate of potash, then 1 ounce of carbonate of soda, then 4 ounces of bichromate of potash, then 50 ounces of water, then 20 ounces of sulphuric acid, and then 12 ounces of common soda. When the above has become cold, to every 40 ounces of the fluid add 20 more ounces of water, 6 ounces of nitric acid and 4 ounces of common soda. 5 claims.

4,660. "Improvements in devices for heating and cooking by means of electricity, including electric flat irons and other articles." H. R. Butterfield and W. Mitchell. Dated March 25th. 8d. Consists in enclosing a layer of continuous wire arranged in coils, between two layers of asbestos, and give to the material thus produced the shape of an oven, a broiler, or other cooking utensil, article or structure, the ends of the coil being also protected by asbestos or other insulating material and the wire connecting terminally with circuit wires so that a current of electricity will pass through it. 16 claims.

5,474. "Improvements in regulating and controlling the resistance of electric circuits." H. Lyon and H. J. Leslie. Dated April 10th. 8d. Relates to resistance cells. Each cell consists of a pot or jar, preferably of circular shape and made of earthenware or other suitable material. In the bottom of this pot or jar is placed a plate of lead, or other suitable metal, in the form of an inverted cone or its equivalent. To this plate is connected one of the terminal wires passing either through a suitable hole at or near to tbe bottom of the pot or jar, or up to the top of the said pot or jar. On the top of the pot or jar is a suitable bar having a central hole in which is a metallic ferrule or bush through which passes freely a spindle carrying on its lower end a metallic plate in the form of an inverted cone, or its equivalent, to correspond with the plate in the bottom of the pot or jar, and on its upper end a small hand wheel or its equivalent. On this spindle is a cut a screw thread with which the end of a stud pin threaded in the ferrule or bush engages, thus forming a nut of the said ferrule or bush, and at the same time affording a ready means of allowing the spindle to move freely up and down in the said ferrule or bush when desired. The other terminal wire is connected to this ferrule or bush and thus indirectly to the spindle by means of small springs fixed to the said ferrule or bush, and adapted to be in constant contact with the spindle. The pot or jar is partially filled with water either with or without sulphuric acid, and by raising or lowering the upper coned plate the resistance is increased or diminished as desired By making the plates connected to the terminals of an inverted cone shape the gases generated between the plates is assisted to escape, so that there is no danger of an explosion within the cell when leaving the highest point of resistance. 3 claims.

6,176. "Improvements in secondary batteries." G. Barker. (Communicated from abroad by H. Woodward, of Toronto.) Dated April 23rd. 8d. Consists essentially in forming each electrode of a series of cylindrical or otherwise shaped perforated tubes made of vulcanised rubber or other acid proof non-conducting material, the said tubes being passed through one or more holders or separators made of vulcanised rubber or other acid proof non-conducting material by which they are held at a fixed distance apart. Each tube contains a spindle or stem surrounded with lead filings, shavings or other small pieces of lead or alloy of lead, the upper ends of each spindle being attached to a horizontal lead connector, and two or more of the electrodes so constructed are placed in a cell preferably made of glass and containing the ordinary solution of sulphuric acid. 2 claims.

6,236. "A new or improved storage battery." A. J. Jarman. Dated April 24th. 8d. Relates to an improved construction of storage battery, termed a "tertiary battery," in contradistinction to those storage batteries hitherto styled secondary batteries. The term "tertiary" is derived from the three distinct and separate actions which take place within the cell, viz.:—1. Decomposition of the water forming the electrolyte, or the major part thereof, into its constituent parts by electrolysis, namely, hydrogen and oxygen. 2. The storage of hydrogen and oxygen in the metal plates and their component parts by the alloying of the hydrogen with one of the metal plates (this gas being considered as a metal in a gaseous state), and the storage of oxygen in the other plate. 3. The generation or production of a current of electricity by the reunion or recombination of the hydrogen and oxygen stored in the metal plates.

6,878. "An improved electric-alarm device for clocks." R. Schmitz. Dated May 3rd. 8d. Claims:—1. The combination, with a clock movement, of a shaft driven by said clock movement, a series of cam wheels on said shaft, a series of electric circuit closers operated by said cam wheels, switch plates connected mith the circuit closers, and electric alarm bells connected with the switch plates, substantially as set forth. 2. The combination, with a clock movement, of a shaft driven by said movement, a series of cams in different positions on said shaft, a series of circuit closers operated by the cams, switch plates connected with the circuit closers, and electric bells connected with the switch plates, substantially as set forth. 3. The combination, with a clock movement, of a shaft driven by said movement, a series of cams on said shaft, a series of circuit closers operated by the cams, switch plates connected with the circuit closers, electric bells connected with the switch plates, a hand on one end of said shaft, and a dial over which the hand can rotate, substantially as set forth. 4. The combination, with a clock movement, of a shaft driven by said movement, a series of cams mounted on said shaft, a series of pivoted levers, of which each has one end rested on the cam, a push rod on each lever, contact springs on which the push rods can act, switch plates connected with the contact springs, and electric alarm bells connected with the switch plates, substantially as set forth.

8,578. "Improvements in electric accumulators or secondary batteries in the manufacture and production of plates or elements therefor." J. Y. Johnson. (Communicated from abroad by C. Hering, of Paris.) Dated June 3rd. 8d. Relates chiefly to a method of preparation consisting essentially in employing a soluble salt of lead as the binding or cementing agent of the pulverulent oxides. 11 claims.

8,599. "Improvements in apparatus for the generation, distribution and commutation of electric currents." F. Anderson. Dated June 3rd. 8d. Relates generally to the procuring in two electric circuits, one of which is auxiliary to the other, of two alternating electric currents, with any required difference of phase of undulation of each current relatively to the other. It comprises the employment of one of these currents of a certain phase to actuate a commuting apparatus in, and at the periods of time proper to convert the alternating current of differentiated phase into a continuous or direct current. 5 claims.

8,800. "Improvements in or relating to electric accumulators." W. P. Thompson. (A communication from abroad by I. Peral, of Spain.) Dated June 7th 8d. Each plate is composed of an outer rectangular frame of the metal and has a series of stout transverse ribs with a long notch or groove along each side. These grooves (after the plate has been removed from the mould in which it has been cast) are opened out by any suitable device, so as to form recesses in which the paste may be securely held. Smaller ribs connect the cross ribs at right angles, and, if desired, these are in turn connected by parallel ones. 4 claims.

10,421. "An improved method or means for the prevention of accidents from the overheating of electrical wires." J. Bradford. Dated July 5th. 6d. The inventor insulates wires in the usual way and encloses them in ordinary metal piping of small diameter. This pipe he again encloses within another of larger diameter, supporting it in the centre by means of perforated discs of suitable insulating material. The larger external pipe he puts in direct communication with the water supply cistern of the house, from which it is filled. 1 claim.

11,402. "Improvements in couplings for electric railway vehicles." L. Pfingst. Dated July 21. 8d. Relates especially to couplings for electric street railway vehicles, the object being to overcome lost motion usual in couplings of this class and jar on the tow cars incidental to stopping and starting the train. 7 claims.

11,465. "Improvements relating to riveting by the aid of electricity." M. W. Dewey. Dated July 22. 8d. Is a method or process consisting essentially in interposing insulating material between the pieces or plates to be riveted together, then inserting the rivet into the rivet-hole or holes and then passing a heating electric current through and between the plates and rivet.

CORRESPONDENCE.

A Refutation.

On page 172 of your present issue is a mis-statement which, if it only concerned myself I should not waste a pen-stroke in noticing. But the statement has been made that the distinguished physicists who composed the British Association Unit Committee (which sat in 1862-3-4) were guilty of applying a law that is only true of steady currents (Ohm's law) to currents that are not steady. This egregious dictum is certainly not supported by the committee's own report, as may be seen from page 102 of Fleeming Jenkin's edition of the collected reports, where the differential equations of the variable currents are given, and duly integrated. What Lord Rayleigh did about 20 years later was to point out that the approximations used in calculating the coefficients were not close enough, and left a small residual error.

The amusing circumstance is that this mis-statement should occur in a lecture *on mental capacity* (or its absence) by the one true infallible prophet who has for twelve months' past been busy in setting us all right, from the President of the Royal Society down to

Your humble servant,

Silvanus P. Thompson.

February 7th, 1891.

Cardew's Earthing Device.

I have been looking up descriptions of the Cardew earthing device, and can find none which really explain the working of this apparatus. Would you be so good as to elucidate the following point for me:—

If the primary leaks to the secondary in a transformer, and there is a dangerous P.D. on the secondary mains, the secondary will be automatically earthed and the primary fuses will go.

Now, the point I wish to ascertain is, whether the current which blows the fuses on earthing is caused by the difference of potential between the earth, and the point on the secondary mains to which the earth wire is attached.

N. S.

[The action of the Cardew earthing device is simply this: It automatically connects the secondary circuit to earth in the event of the difference of potential between earth and the secondary ever rising to 400 volts from any cause. It then depends upon the insulation of the primary mains as to whether the main fuses are blown. In practice it has been found on the London Company's supply that whenever the primary and the secondary came into contact and the secondary is earthed (for this is really the sole consideration) sufficient extra current at once passed through the main fuses to blow them. It can be well understood, however, that a condition is possible in which the resistance of the lead to earth on the primary is so great that the current passing when the secondary is earthed would not be sufficient to blow the main fuses. In this case the consumer would be protected, as the earthing device leaves the secondary earthed as long as these conditions exist. The contention of the makers, Messrs. Drake and Gorham, is, that no conditions have at present been found under which the earthing device has failed to act either during experiment or in practical work, and that it is preferable to earth the secondary when necessary in preference to earthing it permanently, as if the latter course is adopted there is always a danger of depositing the copper off a conductor in a damp wall, or in the case of alternate currents causing corrosion, which produces the same effect, namely, the attenuation of the conductor, and ultimate sparking at this point, a danger against which no safety fuses can guard. The reply to our correspondent would, therefore, seem to be that the action of the safety device is first due to the difference of potential between the earth and the point in the secondary mains to which the earthing device is attached. As soon as the safety device acts, a path of practically no resistance is made between the secondary and earth, and the current which blows the fuses is due to the difference in potential which exists between the primary and earth, there being at that time no difference of potential between the secondary circuit and earth, or, to be more correct, if the earthing device is connected to the centre of the secondary circuit, there would be say 50 volts on each side, or if connected to one of the terminals there would be an earth connnection made by the device on one pole, and 100 volts difference on the other pole of the secondary.—EDS. ELEC. REV].

Electric Tramcar Syndicate.

Allow me to explain and correct, on behalf of my board, one or two statements in your article of last week on the above. The 200 preference shares now being issued form part of the original capital which was held in reserve to fit up charging station and work cars on any line having mechanical powers which might give us facilities for running. One of the suburban tramway companies is now willing to give us these facilities, hence the issue of the reserve capital. Your remark that the motors and gearing "we know will work," is rather "damning us with faint praise," but the notices of our system which you were kind enough to insert in your issues of 30th May, 1890, and 3rd October, 1890, prove that our motors and gearing not only will work, but will work perfectly satisfactorily.

You ask us the reasons for leading us to the belief that we have the most efficient and reliable system of electric traction extant. I fear it would take up more of your space than you would care to give me to quote all our reasons; but I trust you will find room for a few. As you say, Mr. Jarman *has* gained, we believe, much valuable experience, part of which proves conclusively that secondary batteries, as supplied at present, are totally unfitted for traction work, and Mr. Jarman has for the last two years been working on and experimenting with a battery, which, while it does not infringe in any way existing patents, gives more satisfactory results, being lighter, slightly more efficient, far more durable, and last, but not least by any means, is much cheaper. The directors are keenly alive to the fact that accumulators, so far, have not proved satisfactory, but are of opinion that the only system applicable to large cities is the accumulator system, which, although admittedly slightly more expensive to work, owing to grave faults in the accumulators (which no doubt will eventually be overcome) compares favourably in initial cost with either cable or direct current. Jarman's system is equally adaptable for the latter where the surroundings are favourable, and is easily fitted to all existing rolling stock, whether bogie or otherwise. These (in addition to other valuable experiences) are a few of the facts on which we base our views, and, in conclusion, allow me to point out that we do not desire to dispose of our patents untried; on the contrary, we anticipate that in a few weeks we shall be at work, and it has been determined that the expense shall be verified in every possible way, that the cost per mile may be accurately ascertained, without possibility of gainsaying.

Thanking you in anticipation for the insertion of this letter, and the notices you have given us,

James White, *Secretary.*

[We are pleased to give space to this letter and are specially gratified to hear that, at last, we are likely to have a secondary battery which will vie with horse-power in economy.—EDS. ELEC. REV.]

Electro-deposition of Copper.

In the long-continued polemic referring to the cost of electrolytic copper, there seems to be an unexplained mystery capable of exasperating the advocates of one side as well as the investigators of the other.

I personally know nothing of the "Elmore" financial management, nor am I interested in the least in their scheme, but it is easy to give complete estimates of any similar business as well as the exact cost of work, there being nothing novel in the process—not even the principle of the burnisher—all general arrangements and conduct are traced exactly after similar and anterior installations.

The energy absorbed by the deposition of copper is theoretically and absolutely null; in practice it is represented by the resistance of the interposed electrolyte and by the complex and multiple secondary reactions introduced by the impurity of the anodes; but this is not the only item bearing hard upon the work; another is the interest and commercial risk of the capital represented by the enormous stock of metal indispensable to the reduction of the factor, R. The judicious proportion of the two brings a well conducted business to a point of compromise analogous to that given by the rule of W. Thomson applied to distributing conductors.

On the other side is something that everyone seems to forget in these evaluations; those interested in the affair may be desirous to reserve the privacy of their accounts and keep it secret, but there is no reason why the general uninterested public should ignore it. All the mystery disappears when we take into account that *all raw coppers* contain appreciable quantities of precious metals which are found in the muddy deposits of the tanks, and from which they are easily recuperated. This is the obscure item—never or seldom mentioned to the public, and that brings all the misunderstanding.

One example will suffice. The Norddeutsche Affinerie, of Hamburg, deposits in 160 tanks (in two series) 2,500 kilogrammes of electrolytic copper per 24 hours (without interruption day and night for 15 years), and recuperates in 365 days 1,200 *kilogrammes of pure gold.*

The amount is quite sufficient to introduce something noticeable in the accounts of profit and loss at the end of the year.

These remarks may perhaps give to the readers of your valuable REVIEW—if you favour them with your hospitality—a more correct appreciation of the question.

L. Falero.

[Our correspondent is in error when he says that the question of precious metals in the raw copper has been lost sight of. This is one of the sources of profit mentioned at the famous gathering near Leeds, but as it is common to all electro-depositors, we fail to see how it affects the Elmore process *per se*, the value of which, according to its promoters, turns upon the burnisher. If, as will probably be the case, it is clearly shown that others have used similar devices before, then the one claim to originality disappears..—EDS. ELEC. REV.]

The interesting account which has appeared in the REVIEW, of the Elmore process of depositing copper, as witnessed in actual operation at Leeds, induces me to make a few observations on the subject, supplementary to my former letters in your issues of November 28th and January 23rd. It is unnecessary for me to take up more of your space in discussing the relative cost of articles formed of mechanically wrought and electro-deposited copper, beyond stating that all the estimates so far given, of the cost of the latter are much below what is obtained in actual practice on a commercial scale ; but, I should like to place on record the fact that the agate burnishing process under feeble pressure, of which particulars are now before the public, is not the real cause of the excellent qualites of the copper exhibited, but is *parasitic* upon the process of depositing copper when the motion of the electrolyte between the electrodes exceeds a certain limit per unit of current.

The continuous motion of the electrolyte to which the toughness of the copper is due, is a prominent feature in the electro-depositing process exhibited at Leeds, and which, as I have already pointed out, is not Elmore's invention, nor is it claimed for him as such.

I would also further remark that there is no advantage in depositing copper for industrial purposes of greater thickness than $\frac{1}{16}$ inch, as beyond this thickness copper articles can, in the majority of cases, be produced more economically by mechanical operations. It will be obvious to engineers that a maximum density can easily be obtained by submitting tubes of copper only, one eighth of an inch in thickness, to the ordinary process of drawing or rolling, apart from any supposed increase of density by burnishing during the process of deposition.

The important operation of removing the tubes from the mandrel by means of rollers, and at the same time *giving greater density to the copper*, is very creditable to the ingenuity of its inventor ; but, unfortunately for its originality, the section of tube forwarded to you in November last, was produced in precisely the same manner, and this very opportune idea, as Mr. Percy R. Allen testifies in your issue of January 9th, was thrust upon the inventor of the electro-coppered iron roller, fourteen years ago, and he had much difficulty in ridding himself of it.

John Hill.

February 10th, 1891.

Information Wanted.

I shall be obliged to any of your readers who will inform me where I can obtain good electric dials capable of transmitting and receiving say 32 different commands. The pointer must be capable of moving backward and forward and not as in the A B C telegraph always in one direction. I shall be glad to hear from the makers of these instruments.

L. B.

February 5th, 1891.

Jarman's System of Electric Traction.

Referring to your article in the ELECTRICAL REVIEW of February 6th, headed, "The Electric Tramcar Syndicate, Limited," will you kindly allow me to make a few remarks thereon. The system of electric traction that bears my name does not absolutely depend upon the employment of accumulators, for wherever it is desired to use the current direct, the motor, gearing, switches, couplings, &c., are equally applicable, as with accumulators. The reason for adhering so tenaciously to the employment of accumulators is the fact that many tramway directors and others competent to give an opinion agree that self-contained cars are the only practicable means for employment on the lines that run direct to or through our large cities. That each car must of necessity be independent of the others, so that a minimum of inconvenience may be caused in the event of a car becoming disabled, and ramped off the line if necessary.

You refer to the disastrous results of others that pinned their faith to accumulators. What kind of accumulators do you refer to—those used on the Stratford locomotives ? Why, they cost nearly their weight in gold to make and form, and when formed did not possess the capacity anticipated. How was it possible for such a cell to succeed with its weight out of all proportion to its energy-storing capacity, coupled with a motor that used half its power to swing itself round ? There is another storage cell, the grids of which dissolve partnership with their paste the moment they are called upon to do a little extra work, or the plates buckle and bring about their own destruction. Perhaps your remarks are intended to apply to the accumulator cars at Brussels. I am enabled to state, from observations made and noted when there, that the single armature motor in use on the car required 86 to 90 ampères, with an electromotive force of 200 to 220 volts, with a light car carrying only 16 passengers, and struggling hard even with this amount of power to ascend an incline of about 1 in 22 in the Rue de la Loi. Compare this with the figures given by your own reporter, and published in the ELECTRICAL REVIEW of October 3rd, 1890 ; add to this the consumption of coal at the generating depôt of over 7 lbs. per horse-power per hour, and it will be easily perceived that disaster did not come altogether as a surprise to those who knew something of the internal working.

The cars could only carry 24 passengers at the utmost, even when the platforms were loaded. My visit to Brussels was made expressly to see the system which was at that time said to be in practical operation there. Imagine my surprise when I found the Faure-Sellon-Volckmar cells were being used, an electric motor by an English firm, and the gearing of somebody else, I very naturally enquired, where is the Julien system ? The electrician replied, "There is none," and then proceeded to show me a number of things that *had been* used but discarded, which I need not detail here. In fact, in April, 1889, it was clear that the whole affair was in a lamentably mixed up state of experiment. How was it possible for an undertaking in such a state of affairs to lead to anything else but disaster, to say nothing of the burnt-out armatures they had to contend with ? My experience with storage batteries of a well-known kind during the past four years has been, at times, not particularly pleasant, and not altogether satisfactory, so much so, that I have been compelled to devise and work out just such a cell that is capable of withstanding the hard wear and tear which is inseparable when used for traction purposes—one that can be easily and cheaply made, the elements of which are tough and strong, but not brittle, discarding red lead altogether, as well as a pasted grid, fitted with a combined bridge and lug that will neither burn with the heaviest discharge possible to occur, nor break through vibration or handling.

A great deal will depend upon the accumulator employed, its primary cost, suitability for the work, and cost of maintenance. The storage-battery invented by me, and to which I have previously referred, will answer the above requirements, and proof of its capabilities will very soon be shown working side by side with other cells that were supposed to stand to their work. My double-armatured electric motor, with its single set of transmission gearing, has proved itself beyond doubt, by every test applied, that it possesses advantages over every other type for the purposes of electric traction. The gearing stands without a rival, it works noiselessly, friction being reduced to a minimum, and further, it resists the sudden and heavy strains imposed upon it even by the instantaneous reversal of the motor, no matter the speed the car may be running, or the load upon it. Both motor and gearing fulfil all the requirements for which they were designed.

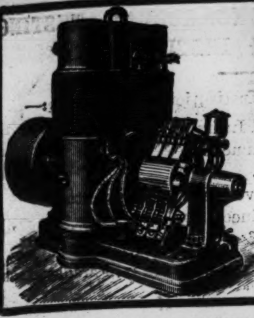
The success of electric traction by accumulators, like every other business undertaking, will stand or fall by its commercial value.

I am aware that other accumulator-cars beside my own are now being operated, but feel sure that absolute success cannot be attained until, as you say, another accumulator be employed to fulfil the requirements stated above. The directors of the Electric Tramcar Syndicate are quite aware of the disasters that others have experienced, but notwithstanding all this, knowing what they do of the system they have taken in hand, and the cautious and searching manner in which every part has been worked out, warrants them in expressing their opinion in the manner they have done without fear of contradiction.

A. J. Jarman.

February 7th, 1891.

A. E. H.—The appliances you refer to are perfectly useless as regards their magnetic properties, they would be equally efficacious if they possessed no magnetism whatever. The statement about the "currents generated" is simply rubbish, and indeed the whole matter is twaddle of the most pronounced kind.



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With the view of considering and reporting to the Corporation as to the whole matter the Special Sub-Committee on Electric Lighting invite Tenders from any Company or Person who may be willing to become, for any period not exceeding 21 years, the Transferees of the Corporation for the purpose of undertaking all the obligations which by the Order are imposed on the Corporation with reference to the compulsory area of supply defined in the Second Schedule to the Order.

Intending Offerers will require to undertake to have suitable and sufficient distributing mains for the purposes of general supply laid down throughout every street and part of a street within said area on or before 14th August, 1892, and will also require to state—(1) the period for which the transfer will be undertaken; (2) the rent or other pecuniary consideration they are prepared to give to the Corporation in respect of such transfer; (3) the system or systems by means of which they will supply the electrical current; (4) the security which will be given for the due implement of the agreement entered into between them and the Corporation; and (5) the terms on which they will be prepared, upon the expiry of the period of transfer, to give the Corporation the option of purchasing and taking over the whole of their undertaking.

Copies of the Corporation Provisional Order, and any further information desired by intending Offerers, may be had on application to the Subscriber; and Sealed Tenders, endorsed "Electric Lighting," will be received by him on or before Saturday the 28th Current.

The Special Sub-Committee do not bind themselves or undertake to recommend to the Corporation for acceptance the highest or any Tender.

J. D. MARWICK,
Town Clerk.

City Chambers, George Square,
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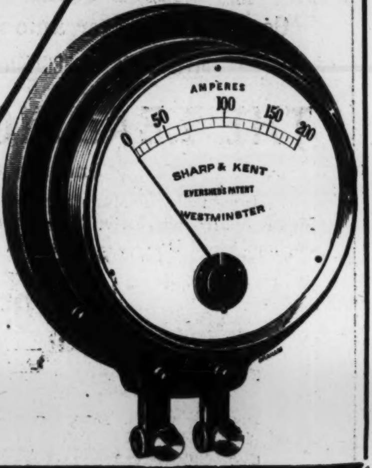

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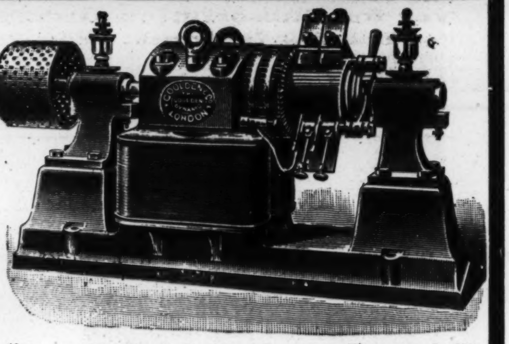

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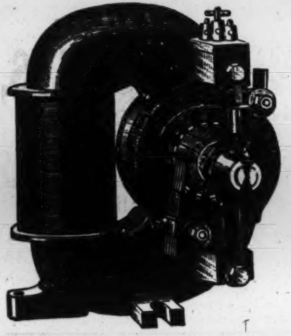

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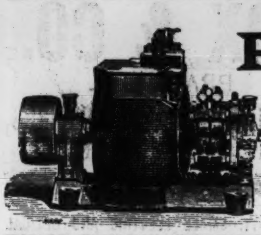

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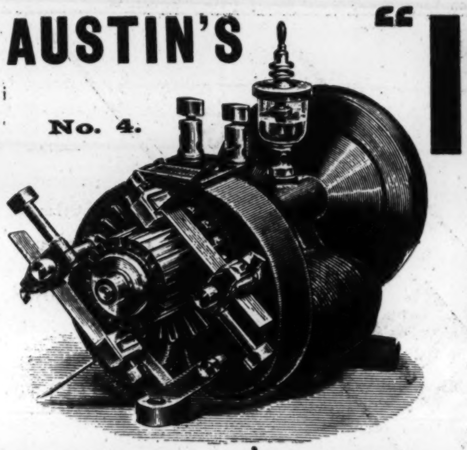

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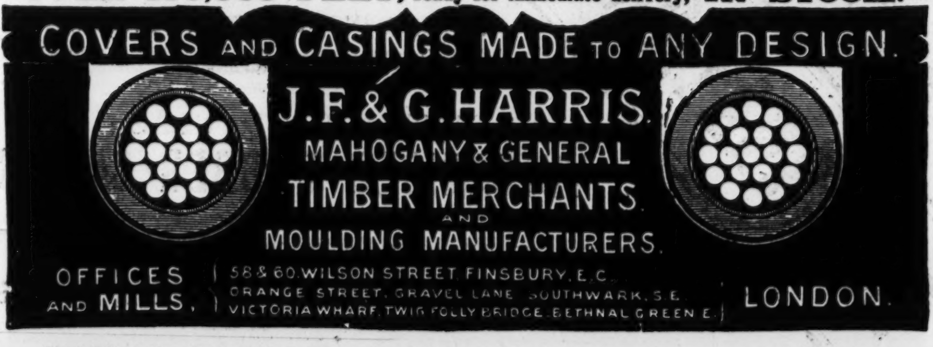

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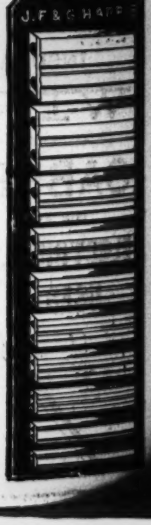

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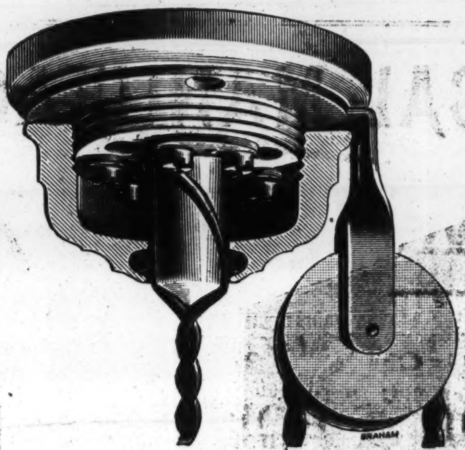

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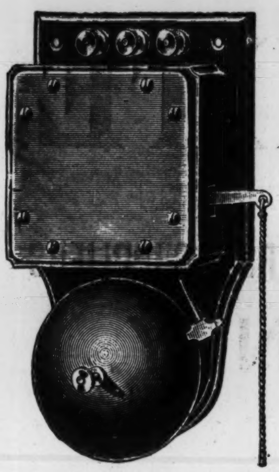

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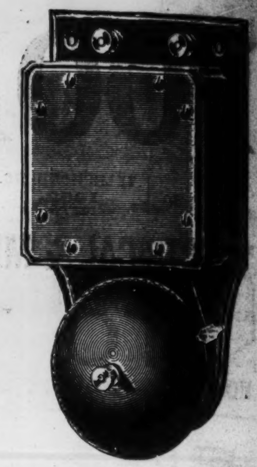

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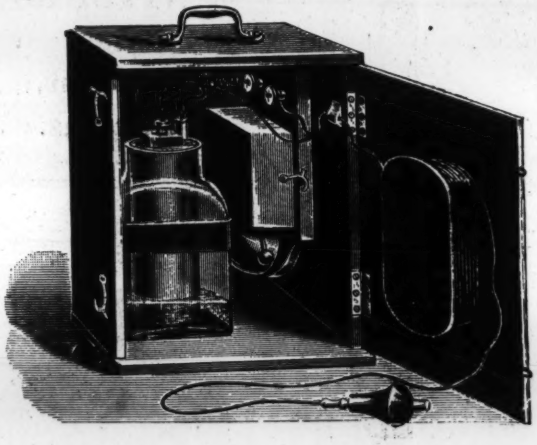

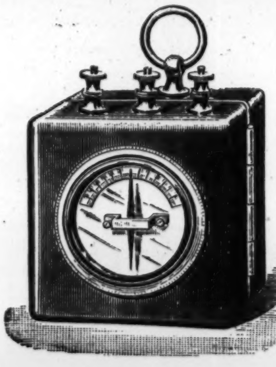

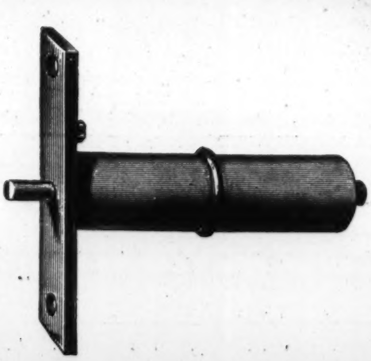

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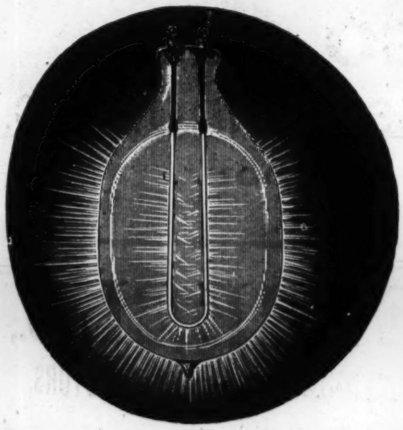

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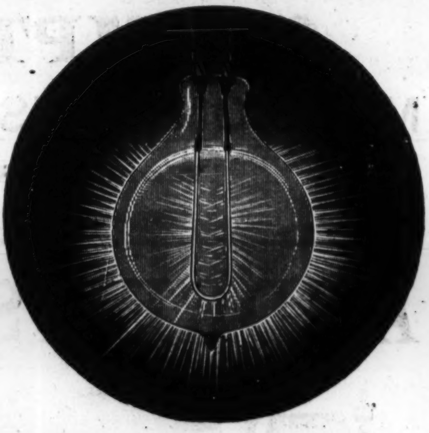

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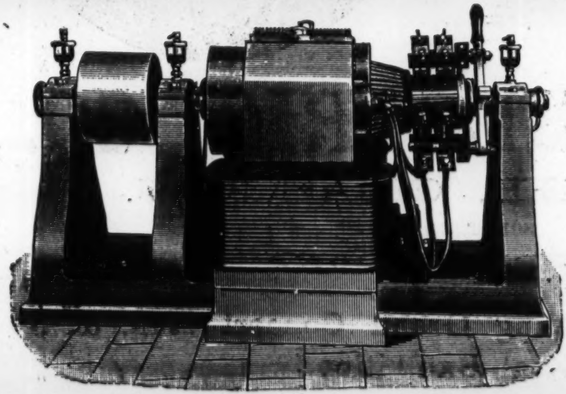

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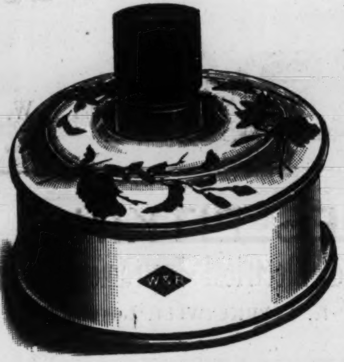

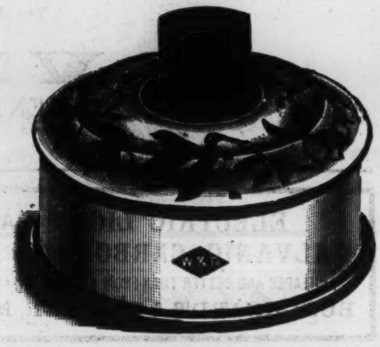
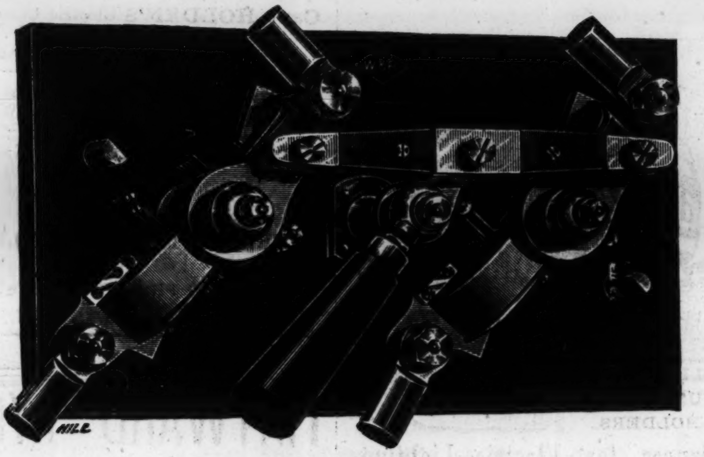

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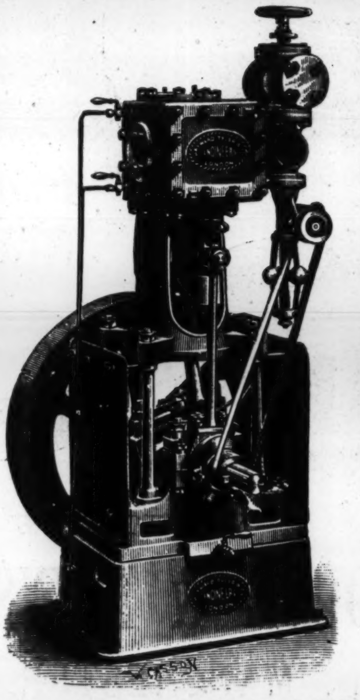

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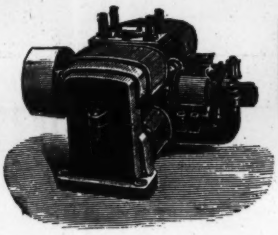

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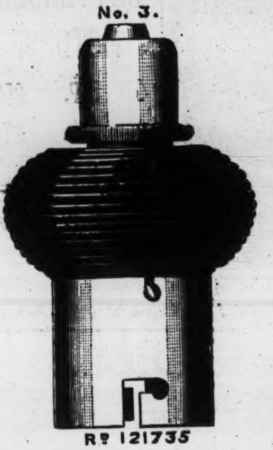

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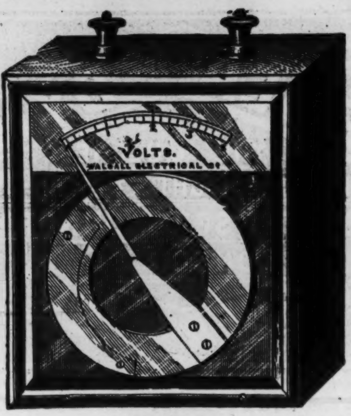

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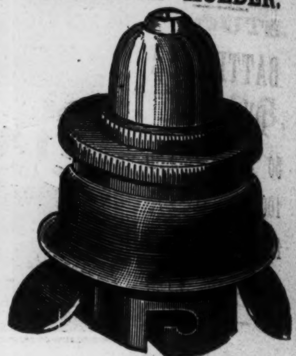

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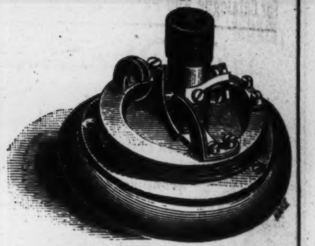

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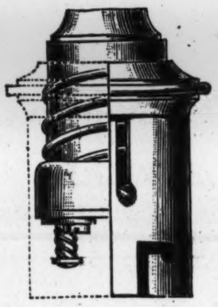

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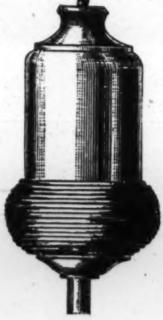

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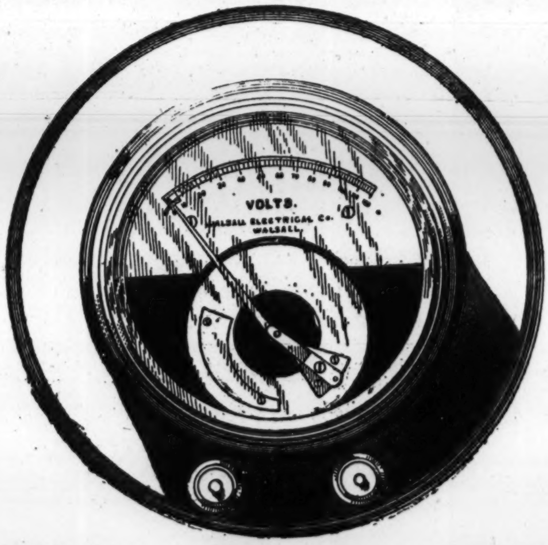

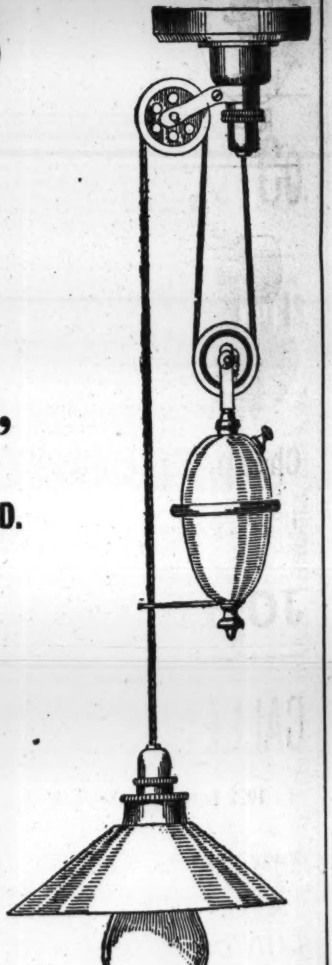

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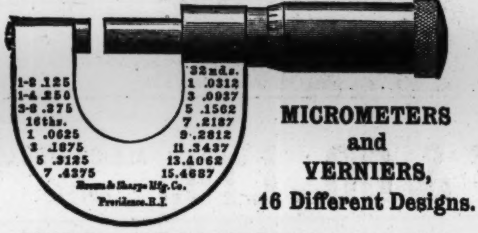

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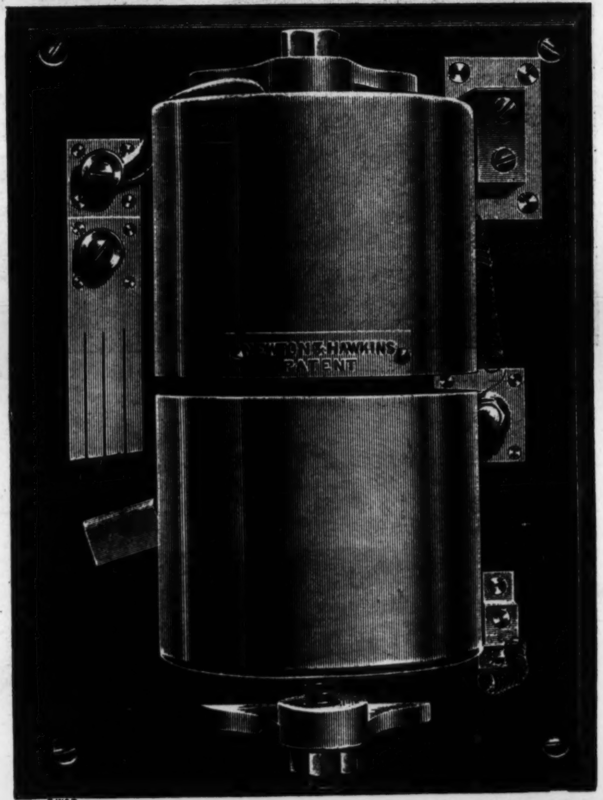

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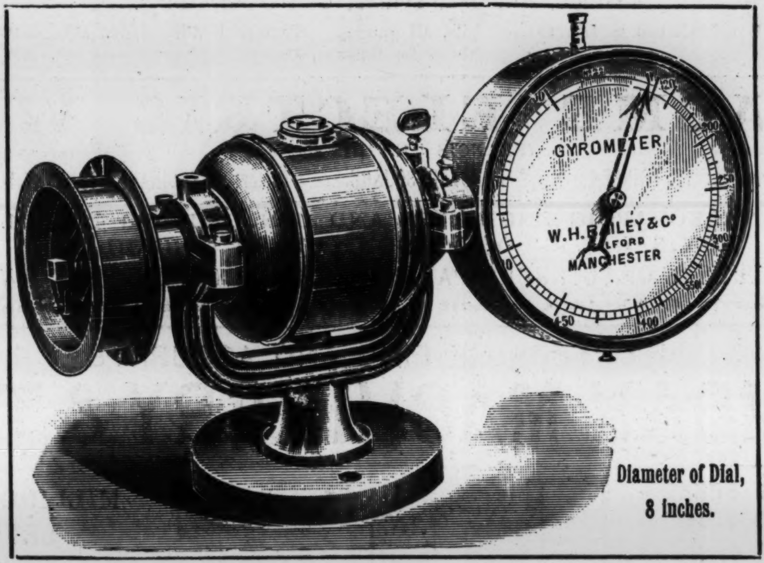

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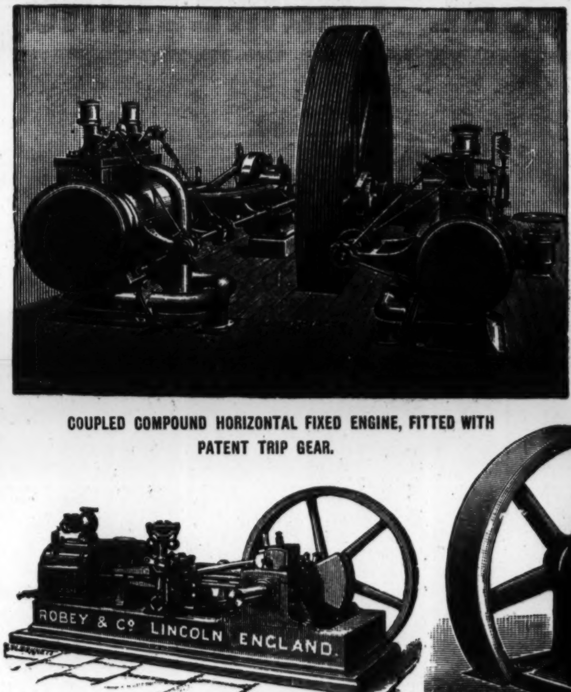

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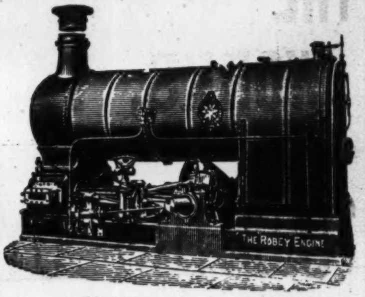

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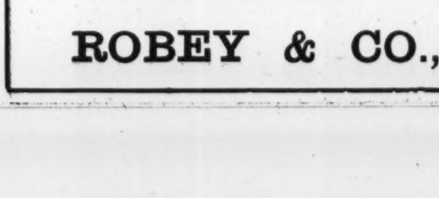
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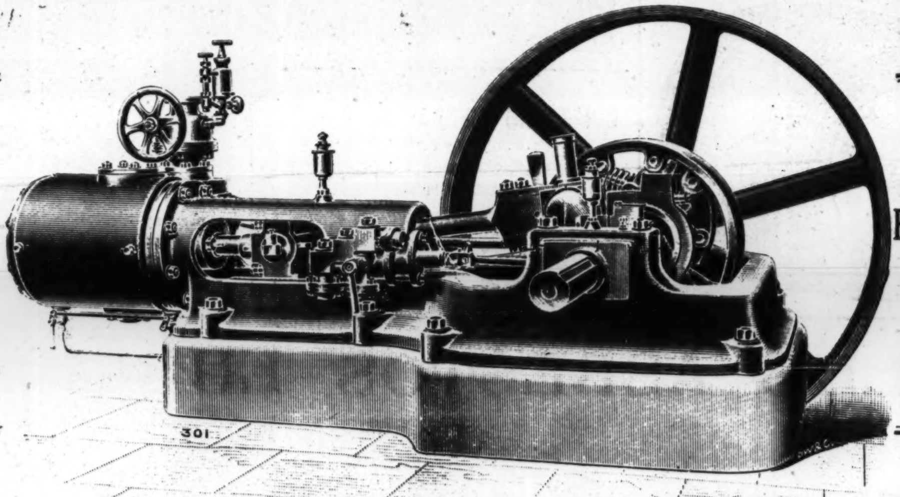

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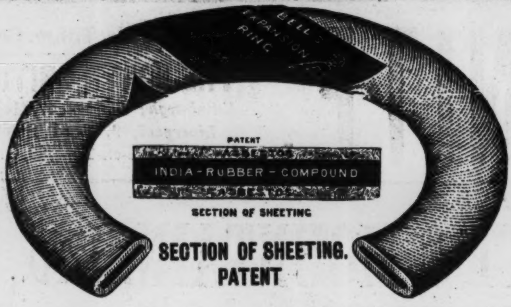

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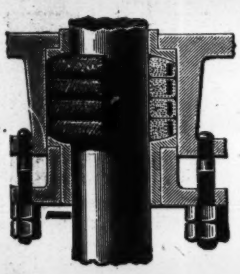

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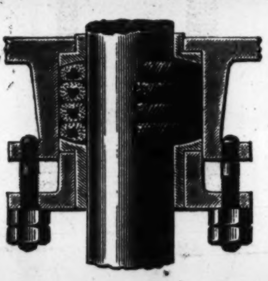

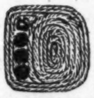

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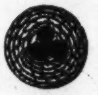

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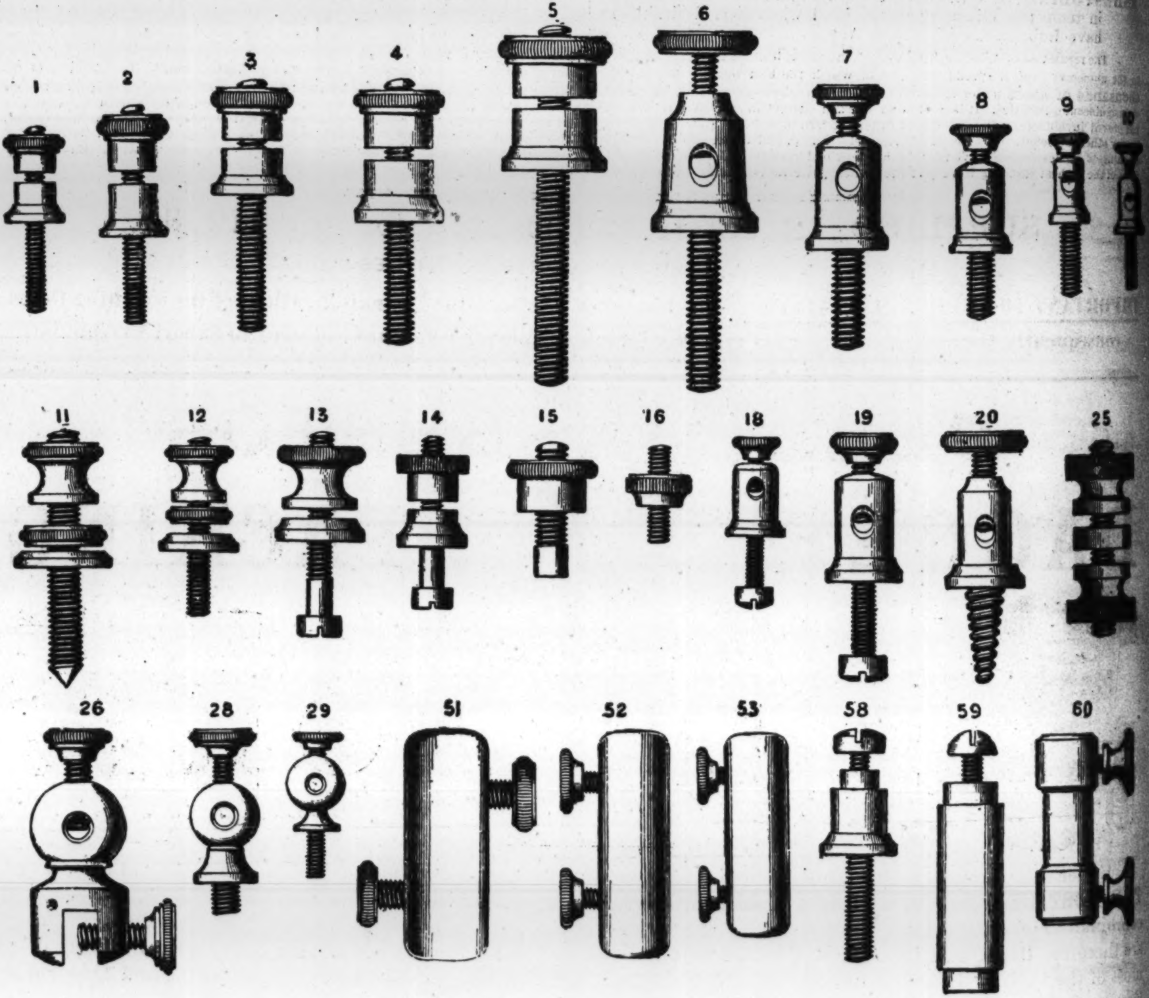

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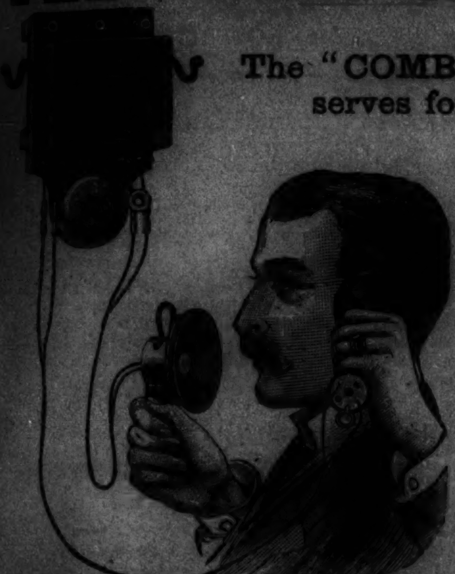

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